The TLT Group
Teaching, Learning and Technology
A Non-Profit Corporation

Flashlight™ Cost Analysis Handbook: Modeling Resource Use in Teaching and Learning with Technology

Version 2.0

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With special thanks to:

Indiana University
American Association for Higher Education
Annenberg/CPB
National Association of College and University Business Officers

PREFACE: THE TLT GROUP AND THE FLASHLIGHT PROGRAM

The Teaching, Learning, and Technology Group, a not-for-profit company, helps institutions improve teaching and learning with technology. The TLT Group provides assessment tools, materials, online and on-site training, and consulting to help clarify goals and strategies, assemble a balanced portfolio of educational improvements, deal with the support service crisis, rethink courses of study, improve teaching in individual courses. In addition to its institutional subscriptions, online workshops, and consulting services, the TLT Group also provides a wide range of free materials and webcasts.

The TLT Group's Flashlight™ Program is the largest and best-known program in the world to help educators assess educational uses of technology. Flashlight provides training, consulting (including external evaluations), and evaluation tool kits. This Cost Analysis Handbook is one of over 20 tool kits, study packages, rubrics and tutorials produced and distributed by the Flashlight Program. Most Flashlight resources are available only to subscribing institutions, which receive site licenses. Subscribing institutions receive a site license for this book, for example, which means they can legally make copies of this book for their own staff and students. Individuals may buy copies of this book from The TLT Group, but are not permitted to make copies of the book.

Flashlight also offers a wide range of free articles, case studies, slideshows, and other resources. For example, this program has a free e-newsletter, F-LIGHT, published approximately every six weeks, which features case studies of successful studies and news from the Flashlight Program. For a free subscription, send e-mail to listproc@listproc.wsu.edu with no subject header. The message should say "SUBSCRIBE F-LIGHT yourfirstname yourlastname".

To order additional copies of this publication or for information about Flashlight tools and services, visit our web site at www.tltgroup.org or send a message to flashlight@tltgroup.org.

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ACKNOWLEDGEMENTS

The economic model for assessing resource use described in this *Handbook* was developed by Indiana University and adapted for use with technology issues by the University under contract with the Annenberg/CPB Project of the Corporation for Public Broadcasting. The concept of the economic model has evolved as part of a process that is used throughout the Indiana University campuses. The Responsibility-Centered Management (RCM) approach is being adapted by a growing number of colleges and universities to better manage costs. At Indiana University Purdue University Indianapolis (IUPUI), for example, the Economic Model Office helps to "assist deans and directors, faculty and staff in reaching their school and unit goals through the application of cost/revenue assessment and planning tools." The book also incorporates some of the "lessons learned" described by authors from several countries that are described in the case study section of this volume.

This second edition of the Flashlight Cost Analysis *Handbook* was created with additional funding from the Andrew W. Mellon Foundation and with support from institutions subscribing to The Flashlight Program.

Many people were directly responsible for the development of this model and production of this *Handbook.* We owe a special debt to Joseph G. Lovrinic, Management Advisor at Indiana University, who was responsible for the initial adaptation of the IU model to this purpose and who directed the beta testing process. James Johnson and Susanmarie Harrington at Indiana University Purdue University Indianapolis, Michelle Cometa and Christine Geith at Rochester Institute of Technology, and Tom Henderson and Gary Brown at Washington State University helped to beta test the model and provided feedback on the *Handbook.* Trudy W. Banta, Vice Chancellor for Planning and Institutional Improvement at Indiana University Purdue University Indianapolis, reviewed the cost model and *Handbook* and provided us with valuable comments. Robin Etter Zúñiga, Associate Director of the Flashlight Program, helped facilitate the collaboration process and assisted with editing. Catherine Colbert designed the cover for Version 2 and Roxanne Picou provided copy editing and layout services.

John Milam, with George Mason University when we started the first edition and now with HigherEd.org, has been generous with his time in working with me on this project. I'm especially grateful for his good work and good humor.

Finally, we thank the many colleagues with whom we have discussed these ideas at Flashlight subscriber institutions and professional meetings. This publication has benefited from their insights.

Stephen C. Ehrmann
Director, The Flashlight Program
The TLT Group, Inc.
January 19, 2003

INTRODUCTION

There are several reasons to take a fresh look at the costs of using technology in education.

1. Information about costs in higher education is relatively ambiguous. That goes for all aspects of education and includes costs of programs and services that use technology, or support its use.
2. There is alarm on many campuses that technology costs are out of control. When is this true? Are there circumstances where technology use *does* help reallocate time, money or other resources?
3. The rapid pace of technological change, and the resultant frequency of programmatic innovation, make past experience a less reliable guide, and increase the chances of cost over-runs and staff burnout, especially when technology use is rapidly expanding.
4. In an era of national and state budget deficits, technology can be one of the first targets for cuts.

CONFUSION ABOUT COST DATA

Assessing the costs of educational activities using technology has never been easy. Over the past five years, there have been mounting debates about costs and prices in higher education. The National Commission on the Cost of Higher Education (Harvey et. al., 1998) recognized that financial information about higher education remains hidden "in a veil of obscurity."

As a result of the Commission's recommendations and the Higher Education Reauthorization Act of 1998, Congress mandated a three-year College Cost Study. The recently released *Study of College Costs and Prices, 1988 to 1997-98*, produced by the U.S. Department of Education's National Center for Education Statistics, found "variations in the nature and the strength of relationships between costs and prices across type of institutions, and within types of institutions over time" (U.S. Dept of Ed, 2001, p. vi). Most significant are the variables of declining state appropriations, increases in instructional expenditures such as faculty salaries, and increasing reliance on institutional aid or tuition discounting. According to Gordon Winston in his commissioned paper for the Study, "prices never cover costs so every consumer is subsidized" and "Colleges are part charity and part commerce – churches and car dealers" (2001, pp. 117-118). These facts have at least two important consequences for cost studies:

a) studies about the expense or break-even possibilities of programs in one institution or state do not mean that similar programs elsewhere will have similar costs or revenues, and
b) cost studies will often need to deal with confusing questions about appropriate levels of subsidy.

The National Association for College and University Business Officers (NACUBO) also responded to the Cost Commission report. In "Explaining College Costs: NACUBO's Methodology for Identifying the Costs of Delivering Undergraduate Education" (2002), the Association reported on its widespread effort to develop a uniform methodology and conduct pilot tests. Pilot test results with 150 institutions reveal that, as predicted, "cost exceeds price" and that "the greatest costs are for instruction and student services." The most important result from the NACUBO effort is a well-defined methodology and agreed-upon approach for measuring the cost of education at different types of institutions. This will allow for more refined and useful benchmarking, something long sought by NACUBO and others.

Part of the problem, according to Hans Jenny in another NACUBO publication, is that "higher education accounting is not organized to answer questions concerning the full costs of teaching a conventional course, conducting a seminar, admitting a freshman class, or managing the institution's heating and cooling system...Sometimes the normal accounting system is so far removed from what is needed that elaborate new stand-alone costing models must be constructed" (Jenny, 1996, p. 93).

A growing group of institutions, including many within the Consortium of Liberal Arts Colleges and the Council of Independent Colleges, are working on another type of Costs Project. The study is driven by the perception that "Leaders of IT organizations are troubled by the lack of reliable benchmarks or comparative data on which to base decisions about support services" (Leach and Smallen, 1998, p. 38). The project has developed a comprehensive survey for submission by IT directors to help them pool data across institutions. More information is available at http://costsproject.org.

DECREASING IT BUDGETS

Academic computing budgets continue to decline, according to annual surveys conducted since 1990 by Kenneth Green's Campus Computing Project. Over 18.3% of respondents reported a decline in 2001, compared to 11.7% in 2000. This "comes at the end

of a seven year cycle in which campus technology budgets increased dramatically" (Green, 2001, p. 2).

This change is driven in part by state budget crises across the nation. "Technology is on the chopping block," and "states and institutions view technology spending as expendable," reports Carnevale (2002, p. A29). Green explains that the downturn in technology spending was predictable after seven years of growth; he points out that state funding is an "easy target in an economic downturn" and that "many elected officials believe that 'technology had its turn'" (Green, 2002, pp. 46-47).

RELATED EFFORTS TO STUDY THE COSTS OF EDUCATION

Thousands of institutions across the world are trying new technologies, upgrading their computer labs, creating online courses, and examining the cost issues involved. While the Flashlight Program and this *Handbook* are intended to provide leadership in this arena, much can be learned from the more general higher education cost literature and from the many case studies and best practices about using emerging technologies.

In particular, two sources are critical to readers who wish to understand the topic of costs on a basic level. The first source includes the publications of the National Association of College and University Business Officers (NACUBO), particularly Jenny's (1996) *A Cost Accounting Handbook for Colleges and Universities*. Other classic NACUBO monographs for cost studies include *A Cost Accounting Handbook for Colleges and Universities* (Hyatt, 1973) and the *NACUBO Handbook: College and University Budgeting* (Meisinger, 1994). Another resource developed by a consortium of institutions and agencies in the United Kingdom is the *Management Information for Decision-Making: Costing Guidelines for Higher Education Institutions* (Joint Funding Councils, 1997). Both provide a sophisticated approach to costing and understanding the myriad of factors that must be considered, such as faculty workload and space utilization. They include numerous print worksheets, the latter with many electronic spreadsheets.

Most interesting in these sets of resources is their presentation of a sample method for costing an individual course, which is sometimes a useful unit of analysis when looking at the implementation of technology. While Jenny presents a micro-costing, full cost, four-tier model of allocating expenditures and revenues to a specific course, the United Kingdom's Joint Funding Councils study uses a hybrid of the activity-based costing model and one typically associated with indirect cost recovery. These terms will be defined later and are included in the Glossary in Appendix A. As readers learn more about costing and apply the specific Economic Model suggested in this *Handbook*, they will recognize an evolving and hybrid approach that takes assumptions and components from several different methodologies.

This *Handbook* is unique, in that it helps the reader focus on developing a model that is unique to their use of technology and situation. Related efforts by NCHEMS, WICHE, and the Center for Academic Transformation promote specific models with detailed instructions for their completion.

OTHER EFFORTS TO MODEL THE COSTS OF EDUCATIONAL PROGRAMS USING TECHNOLOGY

The United Kingdom and Canada: The research study on the "Costs of Networked Learning" conducted by Paul Bacsich and others offers an important set of guidelines and models for approaching instructional technology costs. The authors conclude that, "[t]he good news is that we believe that the problem can be analyzed not by educators inventing a new vocabulary for finance and planning (as some have effectively tried to do over the years), not by their denying the need for such tools (as others have often tried), but by using the tools that are (slowly) being used in universities to solve more general and management problems" (Bacsich et al, 1999, p. iii).

Various sectors or types of institutions in Great Britain were surveyed for the Costs of Networked Learning project and the study's conclusions are important to consider at the outset of this *Handbook*. First, no one really knows how much networked learning actually costs, primarily because little literature in this area exists. Bacsich, et al describes the number of publications as "confinable, with a slow rate of accretion. The sources are diverse, with only a small proportion of direct relevance and high quality" (1999, p. 75). There are relatively few studies that examine costs and cost-effectiveness in computing, Bakia (2000) also finds. The author outlines the methodology of a World Bank study that looks at the cost of information and communication technologies at selected institutions in developing countries. Second, the topic of costing technology-enriched courses is very nebulous. Ash and Bacsich liken the cost inquiry to "weighing air," a phrase which "describes the process of quantifying

something that quite definitely exists but is normally invisible and can only be measured by using special tools" (Ash and Bacsich, 1999, p. 2).

Rumble (1986, 1992, 1997, 2002) has also contributed significantly to the study of technology related costs in developing countries. In his most recent effort, "Analyzing Costs/Benefits for Distance Learning Programs," he explains that "each technology used also has a different cost structure" (Rumble, 2002, p. 62).

Finally, the work of Anthony Bates (e.g., 1995) in Canada has been invaluable for educators who need to do practical studies that look at both program performance and costs.

The United States: The cost and profitability of online education are analyzed in a series of studies commissioned by the Alfred P. Sloan Foundation. Six institutions that received grants from Sloan's Asynchronous Learning Network to develop online programs were used for case studies. The studies vary considerably in what they count in costs and expenses (Carr, 2000). These case studies and other materials have been incorporated into myriad conference presentations and publications, among them the three published volumes of Online Learning. Among the questions raised in Volume 3 is: "How can schools drive down costs and prices to achieve capacity enrollment while maintaining and improving the quality their distinctive missions have established?" For more information, see http://www.aln.org/.

Beginning in 1996, the Andrew W. Mellon Foundation has funded twenty-five projects as part of its "Cost-Effective Uses of Technology in Teaching" program. This program is responsible in part for the development of the Costs Project, the WICHE Technology Costing Methodology (TCM) Project, and this TLT Flashlight Cost Analysis Handbook. Institutional projects have three components: (1) measures of pedagogic effectiveness, (2) measures of costs of teaching, and (3) assessment of cost-effectiveness, as a ratio of (1) and (2). The cost model methodology in each study varies, though over time many similarities and best practices have been shared and incorporated.

One interesting variation in the emerging development of cost models comes from the CEUTT project at the University of California, Davis. The costing work of Maher and others focuses on two types of analysis – the cost of acquiring resource capacity versus the cost of using resource capacity. Developing capacity to use technology (e.g., hiring new faculty and support staff; wiring buildings) can sometimes be very expensive. Using capacity (e.g., allocating the time of staff to develop and teach a new course) requires a different type of measure and is not necessarily less costly (Maher et al., 2002).

The mission of the Western Cooperative for Educational Telecommunication (WCET) is to advance the effective use of technology in higher education. WCET is a program of the Western Interstate Commission for Higher Education (WICHE). One of its first steps in dealing with cost issues was to help create The Flashlight Project in 1992 and begin the work on cost studies that led to this *Handbook.* In 1997, WCET partnered with Dennis Jones of the National Center for Higher Education Management Systems (NCHEMS) to work on standards for cost measurement. Out of this partnership came the Technology Costing Methodology (TCM) project, funded through a two-year project by the Fund for the Improvement of Postsecondary Education (FIPSE). Information about the TCM projects, including case studies and a "TCM Tabulator," is available at http://www.wiche.edu/telecom/projects/tcm.

Over time, TCM has evolved into a complex methodology with its own instructions, training, tools, and case studies. The basis of the methodology was NCHEMS' 1974 "Cost Funding Principles." These principles are at the heart of a variety of models of the cost of instruction that have been created over the years. In collaboration with others working in this field, these principles were refined through new case studies involving technology supported instructional programs.

Seventeen institutions participated in pilot testing the TCM project. Some of these studies found that their technology-mediated delivery systems cost more than campus-based equivalents and that differences in costs arose for different reasons, depending on the method of delivery. A TCM 2 Project is underway, designed to standardize the WICHE methodology and further assist with policy decisions about technology. Flashlight is contributing to TCM 2 as well.

The TCM focuses on direct costs that may be allocated back to instruction. As in the work of Jenny (1996) by NACUBO, the course is the unit of analysis. Nine steps are used in documenting the costs of a course, among them establishing an activity structure, identifying resources, assigning costs to activities, and documenting student headcount and credit hour activity. Costs are calculated per student and per credit hour. There is also a focus on underutilized capacity, similar to that discussed by Maher (2002).

Frank Jewett, drawing on what he had learned from an earlier Mellon-funded project, helped WCET shape the emerging TCM through his work on campus level costs, in combination with the TCM's course level costs. While with the California State University system, Jewett developed the "Bridge Model" to compare the cost of expanded instruction with mediated versus classroom delivery. When the Mellon-funded project ended, Cal State allowed WCET to take over the project. It was recognized that the "full-blown BRIDGE project was beyond the needs of most of the pilot sites, so a new simplified tool, mini-BRIDGE, was created to assist in making the link between the two projects" (Jewett, 2002, p. 5). Jewett applied the mini-BRIDGE model at each TCM pilot institution. The recently published results , termed the "TCM/BRIDGE Project" (Jewett, 2002), include the methodology, cost calculations and comparisons, outcomes, and case studies. The report allows for some level of comparison of costs, though it is recognized that the "calculation of costs based upon the TCM Handbook or any other methodology is a very different thing from the comparison of costs" (p. 14).

The Pew Grant Program takes a different approach to cost-efficiency in Course Redesign conducted by the Center for Academic Transformation at Rensselaer Polytechnic Institute. The purpose of the program is to "encourage college and universities to redesign their instructional approaches using technology to achieve cost savings as well as quality enhancements." More information is available at http://www.center.rpi.edu/PewGrant.html. The Course Redesign process involves using a "Course Planning Tool" or spreadsheet to compare before and after costs of implementing a redesign. There are many ways to redesign a large, lecture section of an introductory course, which is where the project focuses most of its attention. These include keeping enrollments the same, but reducing instructional resources; increasing enrollment but not resources; and reducing the number of course repetitions required to pass a class. Instead of the traditional focus on contact hours, there is greater reliance on asynchronous, self-paced learning. Faculty time-on-task is shifting to technology, which requires challenging existing assumptions that "get in the way" (Twigg, 2002).

Some of these approaches incorporate traditional accounting and cost analysis procedures, while others allow for hybrid models. The CEUTT project lets institutions choose their own methods for costing and quality assessment, within a range of efforts supported in the literature. The projects build on the success of earlier grants and have developed a consistency in method over time. Many of the CEUTT projects use Activity Based Costing (ABC), defined later in this section and built into most of the Flashlight case studies.

What is important to recognize is that, unlike the new NACUBO methodology for calculating the cost of undergraduate education, there is no one right way to calculate the cost of using technology. There are many different ways to get at different questions. If your question matches that used by TCM or Bridge or Pew, then it is worthwhile to explore these approaches. However, this Handbook goes far beyond a single method, giving you the knowledge and tools to build cost models unique to your institution and that will provide you with important feedback about the issues that matter most to you.

HOW DOES THIS *HANDBOOK* RELATE TO OTHER EFFORTS IN MODELING COSTS?

Many of the other programs discussed (e.g., Pew, TCM, BRIDGE) begin with a common purpose: to compare two or more programs, or types of programs, each of which uses technology in a particular way to educate students. The question is: which is cheaper, while also understanding the impact on quality. In order to use the models, users must study the exact same question, adhering to the model's definitions and standards. The benefit of this approach is the ability to compare costs across programs, departments, and institutions.

The problem with this approach is that most of the reasons people have for studying costs do not fit easily into one of these preestablished models. Instead, this Handbook teaches how to apply a flexible set of methods to do studies tailored to your own problems and information resources. The particular method emphasized in this Handbook, activity-based costing, is also well suited to develop studies that can show how to change local practices in order to improve results while controlling costs. Activity-based costing is also a good fit with Flashlight's activity-based methods for studying program performance and outcomes.

It can be quite valuable to study the models discussed in earlier sections so that you may draw from them or participate in them if appropriate. We suggest, however, that you use them as a starting point. Explore the case studies of this Handbook as a way to get started; then focus on building your unique model to meet the questions that face you and your institution.

Cost analysis of a teaching innovation ought to be an inseparable part of a larger inquiry. Such an inquiry

should typically seek answers to at least three types of questions:

(1) What people are actually doing in a program (e.g., how they are actually using technology to support teaching and learning activities) and why they are choosing to do things that particular way. The latter type of information can be very helpful in improving activities;

(2) The outcomes of those activities;

(3) How do those activities use resources; what kinds of stresses do those activities create on budgets and staff? How might those stresses be reduced?

It is with this third set of questions that concern this *Handbook*.

OUTLINE OF THE *HANDBOOK*

Readers may want to follow the *Handbook* systematically when looking at a particular question of interest. The general examples in each section of Part II include basic spreadsheet models to collect data and build ratios and equations that relate different variables and cost drivers. Part III includes the worksheets for a sample application of the model. Its intent is to breathe life into the process by placing it for a specific question – in this case comparing the costs of a traditional section of a course with a section that uses Internet technology and meets less often.

Appendix A is a glossary of terms used in the *Handbook*.

Appendix B presents in detail the seven case studies referenced in the body of the text. These help the reader see more of the methodological choices and data issues involved in the costing process.

In the first case study, Joseph Lovrinic and James Johnson of Indiana University report on the "Cost Implications of Technology Use in the IUPUI English Department's Core Writing Curriculum." It is useful to read this case in conjunction with Susanmarie Harrington's Flashlight study of educational results of those same courses, which appears in the *Flashlight Evaluation Handbook;* the Harrington study is also available on the Web at http://www.tltgroup.org/resources/fcasestu.html.

David Pope and Helen Anderson analyze the costs and performance of different approaches to organizing undergraduate engineering laboratories at the University of Pennsylvania in the second case study. Their study highlights one key advantage of Flashlight's activity-based approach over more traditional methods. Flashlight's activity based costing approach can separate the onerous and burdensome activities (e.g., faculty and TA time spent in managing grades and student data) from those activities that are fulfilling and productive (e.g., coaching students in the lab). Armed with a model of how time is spent on the onerous activities, the staff can then rethink the process in order to reduce time spent on them. Another nice feature of this chapter is the insight that laboratories in different disciplines have shown by asking students to do experiments that look different on the surface but have the same basic structure (suggesting that in the future common labs with common software can serve multiple disciplines). Why is this important? Cost analysis is often seen as an attempt to slice and dice academic life by people who do not understand the first thing about that life. The approach to analysis recommended by this volume is, we hope, the opposite: helping educate people so that they can examine their own working lives in a new way. The Pope-Anderson study is a good example of that kind of sensitive self-analysis by an academic program.

Chris Geith and Michelle Cometa of the Rochester Institute of Technology share the cost analysis results of their comparison of distance learning and on-campus courses, in the third case study. Their study highlights several important lessons, including the enormous variability of how individuals can spend their time (variation sometimes masked by cost models) and the potential usefulness of separating novices from veterans when analyzing how much time it takes to teach courses at a distance.

In the fourth case study, John Milam describes the cost assessment methodology used for George Mason University for its Andrew W. Mellon Foundation grant project on "Cost-Effective Uses of Technology in Teaching." Milam's analysis draws on decades of research and experience from the NACUBO and NCHEMS literature to provide a hybrid approach to the pure activity-based analysis described in this Handbook. It is a particularly useful approach if the policy options being studied deal with staffing and space (as opposed to the reorganization of teaching-learning practice) and/or if it is not possible to gather faculty workload data on time spent on various activities and tasks. Milam's chapter is also unusual in that it provides a model for revenue implications of the programs he compares.

Many educators assume that cost analyses only need to be done once. In the fifth case study, Susan Tucker and Jamie Kirkley analyze costs in a complex, multi-institution project that helps teachers learn to use technology by involving them in the development of

online instructional materials that teachers can use. Their study demonstrates how an ongoing process of cost modeling can become part of the life and evolution of a program, guiding change in its strategies and structures.

The sixth case study reports how Tom Henderson and Gary Brown of Washington State University compare three different materials development efforts supported by their University. One of the most interesting lessons from their study is how projects that apparently cost the same can look very different when one compares the cost per hour of student use and benefit from the materials.

In the final case study, Craig Blurton, Anita Lee, and Winston Ng compare two methods of making computing widely available at the University of Hong Kong: a laptop-leasing program versus equipping a large number of computer laboratories for students. This study provides vivid detail about the practical difficulties of doing such a study and how one team dealt with those problems. Blurton, Lee and Ng draw parallels between their quest for cost data and Ahab's pursuit of the White Whale in *Moby Dick.*

The variety of these cases demonstrates the flexibility of the Flashlight approach to cost analysis. The ideas described in this Handbook can be applied to a surprisingly wide range of issues involving the use of time, money, space and other resources.

<u>Worksheets.</u> Each of the worksheets presented in Parts II and III is available in electronic format. A diskette containing these spreadsheets in Excel 97 and Lotus format is included with this *Handbook.* Two files are listed in each file format, for example part2.xls and part3.xls.

WHO SHOULD DO YOUR STUDY?

Teams, not isolated individuals, ordinarily create cost models. That is because few individuals have the right mix of expertise in content, modeling, analysis, and dissemination of the results. For most such studies, a substantial amount of work is required--another reason for using a team.

The team should include expertise in the program or activity being studied (often provided by people who work in the program), in the arts of model building (business office staff or other management experts), and in the ways your institution stores data that might be relevant for creating the model (institutional research or business office staff).

There is an obvious tension between building a team big enough to include the needed expertise and representation and building a team small enough to work efficiently. One way to resolve this tension is to have a small "operating team" and a larger "steering group". The Steering Group could include representatives of the offices or types of people by whom whose findings will influence the most, such as the provost's office. This group should include students if you hope to influence the ways that students use resources or if you need students to answer your survey or interview questions.

Where can you find team members? If your institution has a Teaching, Learning, and Technology Roundtable, it should provide an excellent source of guidance about who should be involved in such a study, how it might be funded, and how it should be focused. An assessment office, institutional research office, or teaching-learning center may already be involved in efforts to use Flashlight tools at your institution. This is a good place to go for help in formulating your initial cost questions and in gathering data. Academic computing or instructional technology offices are also involved in a variety of similar tasks, though with less of an assessment or reporting mindset.

Hint: *Teams like this sometimes fall apart but, if you know the traps, they can often be avoided. For example, members may initially overestimate one another's abilities to contribute. A business officer may assume that faculty members have a precise record of how they spend their own time and know <u>everything</u> that students do. A faculty member may assume that a business officer knows how the institution spends every cent of its money, knows the cost per square foot of space, and is a complete master of accounting minutiae. If people see that their expectations of one another have been unrealistic, they sometimes overreact. Faculty may leap to the conclusion that the financial experts understand nothing of what is really involved in teaching. Business officers may conclude that faculty believes money grows on trees. The truth may lie between these two extremes.*

Some advice: *Be patient and keep going, value the lenses of different assumptions, and keep a sense of humor. Taking this kind of a team approach will also promote critical buy-in and ownership of the project from the people most affected by it.*

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PART I: THE FUNDAMENTALS

It is difficult to figure out how much higher education *does* cost. Prices and accounting methods vary by type of institution and with the economic situation. Services may be inexpensive at some institutions because of low resource costs or hidden subsidies. Yet similar services may be quite costly at others, also for local reasons. Complicating the question further is the rapid and not always predictable change in technology prices and performance. Cost considerations are difficult to express and change so rapidly that people need to be careful about making generalizations not supported by empirical data. Caution flags should go up whenever you hear someone say, "The nation can teach English composition more cheaply if it uses technology X." The issues are more complicated and the Flashlight Program's tools and training are designed to assist you in coming to terms with them.

An important distinction needs to be made between *research* on costs, which produces generalizations that are true in the average for many schools, and the *evaluation* of costs, which produces results that are true at a particular school at a point in time. The methodologies described herein may be used for either, but the purpose of the *Handbook* is evaluation on a local scale. It is quite difficult to do inter-institutional comparisons of program costs and this *Handbook* does not deal with that particular challenge.

So what *are* sensible activities on which to focus and what are good questions to ask that might reveal how resources could be stretched and used in more productive or fulfilling ways?

Some of the toughest questions in the study of teaching, learning, and technology revolve around the use of resources. The first challenge is to get past the idea that there is some universal, normal cost for using a particular technology in a particular way. In his classic study of "*The Costs of Higher Education: How Much Do Colleges and Universities Spend per Student and How Much Should They Spend?*", Howard R. Bowen (1980) explains that there is no universal standard for how much money or time is enough in higher education. Bowen's findings suggest that cost savings depend more upon *how* technology is used than on *what* technology is used. For example, two institutions might invest the same amount in Internet infrastructure. One of them might make no significant changes in the academic program, so the cost of the technology would simply be added to other costs. But the other might use that infrastructure to reorganize the academic program and library services, incurring additional up-front costs but perhaps cutting operating costs.

Once you have decided to study, what resources are required to carry on educational programs or processes that rely on, or support, technology use? What standard of judgment should be used to decide whether an activity has cost "too much" or has "saved money" (and compared with what)? Which expenditures should be included in cost models? What other resource uses should be included, or excluded? Space? The value of student time? Network services? Even if we know the history of how we used resources yesterday, does that tell us anything about how the same people and activities will use resources tomorrow?

Despite the difficulty of such questions, it is still possible to make some assumptions, model how activities consume time and money, and then make suggestions for how to make more productive, comfortable use of available resources. For example:

- As describe in the University of Pennsylvania case in Appendix B, David Pope and Helen Anderson studied ways of improving undergraduate engineering laboratories while reducing costs. Their successful strategy helped Penn focus on productive use of faculty time (coaching students) while cutting more burdensome uses of time (grading and record keeping), cutting equipment costs, and getting more productive use of the laboratory space.
- In another appended case, the University of Hong Kong compared their costs for two different strategies of making computers available to students such as leasing laptops versus providing the same computer capacity through publicly equipped labs. For them, the leasing program saved money.
- Washington State University analyzed the costs of three projects, each representing a different approach to improving courses with technology. Although the three projects had cost about the same amount of cash, Tom Henderson and Gary Brown found that one of the three strategies was far more costly than the other two when they asked how many hours of student benefit were created by each dollar of investment.
- Sometimes student outcomes data are critical. In a study not included in this volume, Baruch

College studied related initial investment to the number of students passing the resulting course. Baruch College had started an experimental course called "College Literacy" designed for students with poor skills in reading and writing. A section that did not use computers suffered a failure rate of almost 50%. Students did better in an experimental course that featured considerable use of a real-time computer conferencing system called Daedalus. The instructor's assessment of the exit exams, each of which was graded by three independent readers, was that "the students in the computer-enhanced section consistently wrote longer ...essays rich in ideas and details, organizationally complex, remarkable in their fluency." Pass rates for the experimental course were also much better (about 75%). Although most costs were the same (space, faculty time) for the two courses, the conferencing software added about 7% to the cost per student. However, so many more students passed this course that Baruch estimated that the costs per passing student were 29% *less* than the costs per student passing the course that did not use computers. Cost per passing student can be a good way of expressing the costs of activities meant to improve retention.

Creating models of resource use is not easy and is always controversial. However, a properly designed study can uncover facts that point toward real improvements in both education and costs.

Details: What is an "Economic Model"?

An economic model is a summary of how people routinely use resources in order to accomplish something. Such a model is made up of four major components: (1) activities (what is done); (2) organizational units involved in carrying out those activities; (3) inputs (resources needed to carry out the activities); and (4) outputs (results of those activities). The economic models described in this handbook are expressed as numbers and relationships in a spreadsheet; there will be more to say on the possibilities and limits of such models later.

***Defining "output"**: In this Handbook, the term "output" refers to a completed activity while the term "outcome" refers to benefits or problems associated with that output.*

- *Example of output: a course enrolling 30 students has successfully been offered and completed.*
- *Examples of outcomes: most graduates found jobs; most students completing the course were better human beings than when they started; minority retention was unusually good.*

Another ambiguity of terms is that, depending on what you are analyzing, something that is an output in one model may be an input in another model. For example, if you are analyzing the resources needed to provide network services, student Internet accounts may be an output. In contrast, for a model of online instruction, student Internet accounts might be an input.

Let us define each term in a bit more detail.

<u>Activities and tasks.</u> Activities are processes or functions performed by individuals and organizational units. A study topic usually can be broken down into a number of different activities, each of which may be made possible by work or services from more than one organizational unit. For example, in creating a course, one instructional activity might be creating a CD-ROM of supplemental course materials.

Each activity can be further broken down into *tasks*. For example, in producing a CD-ROM, tasks include outlining content based on the course syllabus, then locating, evaluating, obtaining copyright permission, and converting content into electronic format. It is possible to break an activity down into an infinite number of tasks, but it is not a good idea. Activities and tasks need to be recognizable ways of describing action and its resource requirements. If a total process is broken into too few activities or tasks, one gains too little insight into how it uses resources. Yet too many tiny categories create a huge amount of data collection work for the study team.

<u>(Organizational) units.</u> Academic and administrative units perform the activities, with help from various support units. Developing the CD-ROM may evolve with some of activity taking place as part of the academic department's budget, some from the financial aid department's budget (supporting student assistants), some from the technology support operation's budget, and so on.

<u>Inputs.</u> To carry out the activities, the units require such resources as people's time, buildings, equipment, services (e.g., computer networks), and money for expenses. Models usually need to find a common means of expressing the value or quantity of such resources; money is the most frequently used measure.

<u>Outputs.</u> In our example, the output is a completed CD-ROM. There are two ways to think about outputs

– generally and in terms of performance measures or metrics. For some decisions, it may be important simply to know the total cost of producing the CD-ROM (including various ordinarily hidden costs). However, much more may be learned by looking at different metrics for expressing the output. What is the cost per user of producing the CD-ROM? If using the CD is intended to improve the retention of students in a course, what is the cost per retained student?

As you can see, there are many ways to express outputs. The general output is really a function of the resource question of interest, defined by what it is you want to study. The specific output is a performance measure for examining how much the output cost, using a specific metric or indicator.

RELATING THE INPUTS TO THE OUTPUTS: ACTIVITY-BASED COSTING

Once you identify the inputs, units, activities, and outputs you are interested in evaluating, examine the quantitative relationships between them using an approach called *activity-based costing*. How many dollars, how much space, how much time and what other resources were required to teach that class, to carry out that style of assessing student learning or to develop such a CD-ROM?

<u>Differences between traditional accounting and activity-based cost models.</u> Traditional accounting breaks down costs and revenues by organizational unit (even though each unit is carrying out, or contributing to, many activities). In contrast, activity-based costing breaks down costs by activities (even though each activity is the shared responsibility of many organizational units). These costs may cut across organizational boundaries and include all relevant resources (e.g., use of time, space), even if no unit is currently carrying that 'cost' as part of its operating budget for the year. Traditional accounting covers the whole organization and is rather simple in at least one respect: each person is usually the budgetary responsibility of one unit. In contrast, activity-based cost models focus on one process composed of several activities.

Activity-based cost models have at least three advantages over traditional accounting:

a) They can express costs in a way that can be more easily related to benefits,

b) Activity-based models are usually designed to help people make specific types of decisions (should we teach this way or that way, lease computers or equip laboratories, or reconfigure our undergraduate engineering laboratories?), and

c) Activity-based models make it possible to reduce uses of time or other resources that are unpleasant or unproductive, while investing more time, space or money in ways that are fulfilling or successful. For example, in the Penn study of undergraduate engineering laboratories, the study helped the University take steps to reduce faculty and TA time spent on record keeping while enhancing the time spent on coaching students in the laboratory.

<u>Cost drivers.</u> A *cost driver* is an element of a process that, if changed, would have a significant impact on the resources needed.

For example, a team might "tweak" a model to see how a change affects total resources required by

a) changing the number of students to be handled,

b) changing the assumption of how many students a faculty member can teach, or

c) changing the assumption about how much study materials would cost per handout (e.g., if handouts were made available on the Web and sometimes printed by students instead of being mass-printed and sold).

UNDERLYING ASSUMPTIONS

In constructing any model of resource use, certain assumptions usually need to be made. For example, it is assumed that:

❖ *Modeling processes take place more or less the same way each time they occur.* Notice that phrase "more or less", we know that people never do a task the same way twice. The question is whether their patterns of using resources are consistent enough to make it worth learning from experience. It is not always easy to determine whether there is enough continuity linking past, present, and future. People can be relatively isolated from one another in higher education so that one may assume everyone is doing pretty much the same thing, and be wrong. Alternatively, one might be fooled by radical differences between two people and not realize that the mass of faculty are, on the average, doing things in pretty much the same way. Another mask that can be deceptive comes from technology. Many people assume that, when technologies change, all past experiences

become irrelevant. This purposeful amnesia may prevent them from noticing that patterns of waste and failure repeat themselves with each new generation of investment (e.g., Ehrmann, 2002).

- *Costs can be summed with appropriate metrics.* For example, your model may implicitly assume that, if it costs a certain amount to create 40 copies of a book, it will cost about twice that much to create 80 copies. This kind of assumption may be good enough for your decisions, especially if, when documenting your model, you note the range of operation within which its assumptions are valid. You might, for example, write in your report that "we assumed in creating this model that no fewer than 20 and no more than 100 copies would be made at any one time. Below 20 copies, the price per copy is much higher, while above 100 a different and much cheaper production method would be used."
- *Accurate workload data can be gathered.* When asked about how they spend their time, faculty members, staff, and students can and will answer truthfully if they do not feel threatened by the study and if they have some interest in its accuracy. If it is not possible to gather data about how people spend time on specific activities, it is sometimes possible to use alternative methods outlined in the appended report about work at George Mason University (see appendix B).
- *One dollar (or hour of work) is like another.* This assumption is often made in cost models but we suggest that it be re-examined. It is quite possible to designate specific uses of time as negative (to be reduced if possible) and others as positive (to be increased if possible because they are fulfilling for the people involved and effective for the institution and its students). In fact, the ability to look differently at different uses of time is one of the potential strengths of activity-based cost models.

WHAT ACTIVITY-BASED COSTING IS NOT

Activity-based models do not replace accounting or the traditional method of indirect cost recovery required in sponsored research administration. They have a different purpose: to evaluate a program or process in order to make decisions about it, usually in conjunction with other information about the program such as the quality of its outcomes, the need for its outcomes, barriers to the program, and so on.

Activity-based models are designed to answer quite specific questions – so be careful about applying a model in an inappropriate context. Suppose, for example, that you are interested in the student projects in studio classrooms that might improve retention on campus. You gather data and build a model to help you estimate those savings. Later, you become interested in another proposal to improve retention that (as it happens) involves relying on the Web instead of physical classrooms. Your original model might help you answer that question too, but there might be problems. For example, in building the original model of several classroom-based options, you may have decided to ignore the cost of space because all the options you were considering used the same amount of classroom space. Unless you modify the model to include the cost of classroom space, it will make the Web alternative seem comparatively more expensive than it is in reality. Model making, like other forms of evaluation, requires a consistent, clear focus on the resource question of interest.

Third, activity-based costing, like other forms of evaluative study, does not dictate what you should do next. Evaluative studies are necessarily about what has happened or about people's assumptions about what might happen. Decisions require a creative leap and a value judgment as well as data. Stretching resources is often a good thing, but not always. Thus, findings should shape your mind, not determine it. In an example described in Appendix B, Washington State University (WSU) compared several methods of developing technology-based course materials. The most expensive initiative involved the development of a computer-based tutorial that could be used for a relatively short time by a small number of students, when cost-effectiveness was calculated in terms of dollars spent per hour of student use. What if the modules are essential to recording and preserving Native American languages for future generations? In that case, the institution might reasonably decide to produce more such modules, even though they are expensive, if conserving cultural diversity is valued as part of the institutional mission. The lesson is that tailored modules usually need to have very specific and justifiable goals to justify their relatively steep costs per hour of student use.

A fourth cautionary note about activity-based costing is that most models do not directly relate cost to quality, though occasionally it can be done. You will usually need to use other means, such as the course-specific assessments of achievement and evaluation tool kits developed by the Flashlight Program, to study questions related to quality.

PART II: BUILDING YOUR ECONOMIC MODEL

You can complete the Economic Model in seven basic steps:

1. Identify resource concerns and the specific questions to answer.
2. Identify your outputs.
3. Identify the activities required to produce your outputs.
4. Identify the academic and support units that participate in these activities.
5. Identify the resources these units consume in their activities.
6. Calculate costs for these activities.
7. Tally the costs of all activities to arrive at your output costs.

STEP 1: IDENTIFY RESOURCE CONCERNS AND THE SPECIFIC QUESTIONS TO ANSWER

Evaluative studies always begin with a comparatively ill-defined sense that data needs to be gathered. The first and often hardest step is to define the object of the study. This often requires considerable time and debate. The seven teams whose work is reported in this *Handbook* and its appendices drew quite different conclusions about what to study.

❖ At Indiana University Purdue University Indianapolis (IUPUI), team members decided to analyze sections of composition courses that were offered in computer-equipped classrooms, comparing them with other sections of the same courses offered in traditional classrooms. Using the Flashlight Current Student Inventory, the team was also interested in whether the sections in the computer classrooms were taught differently and better than sections taught in traditional classrooms.[1]

❖ At the University of Pennsylvania, a new way of organizing undergraduate engineering laboratories was analyzed.

❖ Team members at the Rochester Institute of Technology (RIT) had several resource concerns. They wanted to: (1) identify all costs associated with teaching a variety of courses using distance learning technologies, as well as all costs associated with teaching the same courses on campus; (2) discover the revenue benefits of distance learning courses; and (3) determine costs for distance learning staff time and services in order to develop an internal price sheet.

❖ Tucker and Kirkley wove cost analysis into the life of a three-year grant funded project to develop online materials and educate teachers; cost data helped shape the evolution of project strategy.

❖ At Washington State University (WSU), users of the model compared the cost of several alternative ways of spending money on using technology to support teaching and learning.

❖ In conducting its cost analysis of seven innovative courses and their traditional classroom counterparts, George Mason University (GMU) compared the cost-effectiveness of different combinations of technology and personal contact between instructor and student.

❖ The University of Hong Kong focused on infrastructure: whether to expand a pilot program of leasing laptops to students or focus on making computers available through public labs.

The variety of these topics helps illustrate the need for this *Handbook*. Other cost efforts either simply publish results (X is usually cheaper than Y) or distribute models that are useful only for one class of cost problem (is one type of course cheaper or more expensive than another type). In contrast, this Handbook will help you focus your attention wherever it is most needed.

A Fictitious Example

For the purposes of illustrating the description of the Flashlight approach to activity-based costing in this *Handbook*, we will follow the development of a model of a fictitious example: the cost implications of offering a non-traditional class section of a popular course, Sociology 101. In step 1, our team decides to ask the following question:

What is the difference in costs between offering a traditional section of Sociology 101, which meets twice a week for fifteen weeks, and another section that meets only a few times and does most of its work on the Internet?

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[1] This study by Susanmarie Harrington was reported in the *Flashlight Evaluation Handbook and Current Student Inventory* and is also available on the Flashlight Web site at http://www.tltgroup.org/resources/fcasestu.html.

Hints for asking good questions

First, focus on a few activities or processes. These activities should be:

- ❖ technology-related (the activity depends on technology, your use of technology depends on the activity, or both);
- ❖ educationally crucial (the activity has a pivotal impact on student outcomes);
- ❖ resource-intensive (the activities seem to involve a lot of money, people's time, network use, space, and other limited resources);
- ❖ problematic (more information could give you the opportunity to change the activity in beneficial ways);
- ❖ promising, arousing hope that the cost of the study will not exceed the potential gains from the study! Among the gains to consider: stretching or reallocating resources (including uses of time that are most satisfying and productive), gaining new resources, defending budget allocations.

Cautionary note: most cost studies are themselves costly, not just for the team but even more, for the people who need to provide data. Collecting data from staff or students about how they spend their time is quite time-consuming (and therefore costly), for example. A useless study, unfortunately, can be just as expensive as a study that is worth ten times the cost of doing the study.

To help avoid doing a flawed study that is looking at the wrong topic, start by creating a fictional version of your completed study. In other words, as soon as you have picked your topic, make up the cost numbers and present the results to the decision-makers represented in your steering group. Then ask the steering group members how they would use the findings. Make up estimates of what it cost to collect that data (including the time spent by people contributing data; you might imagine that you need to pay them for their time and add that invoice to the cost of doing the study). If your steering group replies that "this data doesn't give us enough evidence for action," or "the study would have cost us more money than it saved," you need to go back to the drawing board.

STEP 2: IDENTIFY YOUR OUTPUTS

When you identify the resource question you are most interested in, the general outputs are often outlined for you. If the process to be studied is the creation of CD-ROMs, then CD-ROMs are usually the output of interest. If you are comparing different ways of developing and supporting online courses, then the number of courses actually offered (or the number of students educated) will probably be the most important output.

For the purposes of this example, we are interested in comparing two classes. Both are sections of the same course, Sociology 101. The same fifteen weeks of course content is covered in each section, guided by a syllabus on file with the department chair. The catalog listing does not differentiate between the two sections, other than to say that one is online and meets less frequently on campus.

<u>Comparing outputs.</u> After you determine general outputs, you will want to set specific performance measures and to think about possible metrics that may affect the variables in the model. In defining specific outputs that may be expressed as performance measures, it is helpful to begin by looking at similarities and differences between the two course sections.

The traditional course section:

- ❖ requires developing a syllabus and printed curricular materials;
- ❖ is taught in a conventional classroom, meeting twice a week for fifteen weeks;
- ❖ serves 35 students who are freshmen or sophomores;
- ❖ requires an instructor at each class meeting. She/he also does routine course administration tasks such as monitoring enrollment, grading, and keeping regular office hours;
- ❖ uses a textbook and a chalkboard format to relay information;
- ❖ uses paper and pencil testing administered with quizzes and mid-term and final exams.

The technology-assisted course section:

- ❖ has the same syllabus and course sequence, but uses electronic curricular materials
- ❖ meets on campus only three times during the semester, for the: (1) course introduction; (2) mid-term exam; and (3) final exam;
- ❖ serves 100 students in a mix of student levels;
- ❖ requires that the instructor be physically present only for the three meetings. The rest of the time she/he monitors online discussions, responds to student email and phone calls instead of keeping office hours, updates electronic content, and does other routine course administration tasks;
- ❖ uses the textbook for assigned readings that are not available online;
- ❖ relies on Internet tools to provide supplemental information. The class website includes an electronic syllabus, links, online class notes, interactive quizzes, and graphics. A listserv and email are also used.

Determine what outputs you are going to study

As you begin work on your Economic Model, it is important to carefully select the outputs you are going to study.

At Indiana University Purdue University Indianapolis (IUPUI), team members wanted to compare the costs of offering traditional versus technology-assisted courses. They had a difficult time making accurate comparisons because there were so many variables among the courses they selected to study. Faculty teaching the courses had different levels of experience and had different motivations for teaching. Some faculty taught full time, while others were part time. Enrollments in the courses were affected by the size of the classrooms in which they were scheduled.

The University of Pennsylvania (Penn) team had a simpler time of defining outputs because their inquiry was defined by their Mellon grant: compare the new method of teaching undergraduate engineering laboratories with the old. One important insight: pay attention to which uses of instructor time were seen as productive and fulfilling, and which other uses faculty and teaching assistants wanted to minimize if possible. In effect, these uses of time were also treated as outputs.

Rochester Institute of Technology (RIT) investigators decided to keep their model simple in order to reduce variability and focus on course delivery, as opposed to content development. They studied eight courses and targeted faculty members who were experienced in teaching technology-assisted courses. In addition, the chosen faculty presented their courses in both distance learning and an on-campus format during the quarter the study was conducted. Narrowing their focus, says the RIT team, made it easier to draw comparisons and to design a model the team could use long term.

At George Mason University (GMU), it was clear that there are many ways in which technology is already being incorporated in teaching and learning. By designing a two-dimensional grid that describes combinations of technology ("tech") and faculty contact ("touch") in courses, the study suggested a new conceptual map for understanding educational strategies and their costs.

The "Learning to Teach with Technology Studio" (LTTS) project presents a more elusive challenge. As this case study details, the outputs of their project (and their model) were changing every year, influencing one another.

Users of the model at Washington State University (WSU) analyzed three typical approaches to development of material for online courses. Because they were only studying one example of each approach, the WSU team found that each output they studied "may have had more particulars than generalities," making it difficult to generalize. Nonetheless, the results were striking and the methods they developed are easy to apply to new cases.

The University of Hong Kong (HKU) compared two different ways of making computers available, leased laptops versus publicly available machines. This raised two challenges of output definition. The leased laptops were available only to their undergraduate 'owners' but the publicly available labs were used by graduate students, too. For reasons discussed in that chapter, HKU treated the labs as though used only by undergraduates. The team also had to decide what output unit to use; they decided to use hours of access to machines, rather than attempt to measure "hours of use of machines." Their reasons were pragmatic: it would have been too difficult to measure hours of actual use, especially of leased laptops.

Define performance measures as specific outputs. For our example comparing two sociology course sections, how might you quantify the general outputs? Costs per student? Faculty hours spent per student?

A *performance measure* provides insight into the efficiency of an activity. There are literally thousands of possible performance measures that you might use. In picking one for your model, make sure that it will get at the resource question of interest, telling you something informative about the costs of what you are evaluating.

Choosing the wrong cost measure can be quite misleading. For example, one of our authors, Gary Brown of Washington State University, has remarked that average cost per student credit hour should usually be avoided in studies of technology use (even though it is commonly used in other aspects of the cost literature). That is because specific uses of technology often occupy differing amounts of time. Brown's suggestion can be illustrated with this simple example. Imagine that two courseware modules, A and B, are developed at a cost of $900 each. One 3 credit course with 10 students uses module A for one week while another 3 credit course with 10 students uses module B for 15 weeks. The cost per student credit hour for each course is $30. However, the cost per student week of use for course A is $90 while the cost for student week of use for course B is $6, an order of magnitude difference!

The results of performance indicators may be interpreted in different ways for different purposes. With an "accounting lens," it is desirable to have more students taught per faculty, indicating that funds from tuition payers, donors, and taxpayers are being stretched to educate more students. A "student learning lens" might interpret those same results to mean that faculty members are overburdened and unable to spend enough time with students, thereby decreasing the chance for quality interaction. Thinking these issues through in advance can be important. For example, if both of these perspectives are valid concerns, the model might be designed to look separately at faculty time spent in direct interaction with students, and other Flashlight tools might be used to gather data directly about student perceptions of interaction. Perhaps some strategies result in both a reasonably high level of interaction and support, but with an acceptably low faculty cost per student (e.g., by enabling faculty to spend less time on tasks that do not directly support interaction and learning)

The sociology example in this section of the *Handbook* uses the following two performance measures:

Performance measures:

1. What is the total cost for each section?
2. What is the total cost per weekly student course hour? Weekly student course hour is defined as the number of hours in which students are enrolled to sit in a course (usually 3 hours per week per student for fifteen weeks).

<u>Defining metrics for cost drivers.</u> A cost driver is a factor with a strong influence on your output. Suppose that $300 is spent to produce the CD-ROMs to supplement a course. To determine the unit cost for each CD, you first need to know how many were made. The size of the production run is a cost driver. Since 100 CDs were made with that $300 investment, the unit cost is $3. If instead of making 100, you made 1,000, it is possible that the cost per unit might drop to $1. This is one way a metric can be used to help ask "what if" questions about costs.

STEP 3: IDENTIFY THE ACTIVITIES REQUIRED TO PRODUCE YOUR OUTPUTS

Your next step is to identify the activities that go into offering the general outputs; in our example, the outputs are the two courses. What activities are required? In our simplistic example, our two courses both require the same three activities: preparing the course, teaching the course, and grading.

How might the activities be broken down into specific tasks? For the purposes of this example, we define a "task" as a specific job duty or responsibility

that an individual or an office performs. An activity may consist of different tasks performed by different offices.

Identify your activities and tasks

Identifying the activities and tasks needed to produce your output is one of the most crucial steps in building your Economic Model.

Due to the nature of its resource concerns, RIT focused its model on course delivery and was able to build its activities and tasks around an existing course development model. Activities included course preparation, interaction, and assessment, with about ten tasks for each activity. From the outset, the RIT team enlisted faculty support in identifying activities. It invited faculty to help develop the activity-task matrix, respond to surveys, and participate in mock interviews that helped define the terms the team would use in constructing the model.

At WSU, users of the model identified three major activities. Although they knew that using more activities would yield more information, team members worried that if they selected too many activities, the distinctions among them would blur.

Data collection for cost assessment at GMU included an open-ended, unstructured interview protocol to "tell the story" of each class. In telling the story of their classes, faculty helped to document their workload, identify activities and break them down into tasks, and identify direct costs associated with the tasks.

The University of Hong Kong (HKU) had to define the activities and tasks needed for setup and recurrent costs of both laptop leasing and publicly available laboratories.

As you array the list of activities for each sociology course, the worksheet would probably look something like this:

Activity Matrix (sheet 1)

	Traditional Class	Technology Class
Activity 1	✔	✔
Task A	X	
Task B	X	
Task C		X
Task D		X
Activity 2	✔	✔
Task A	X	X
Task B		X

The checkmarks beside Activity 1 and 2 mean that each activity takes place in some form in both classes. The X in column 1 means that Task A takes place in the traditional class, but the lack of an X in column 2 means that this task is not relevant to the technology class. Task A in activity 2 takes place (in some form and to some degree) in both types of class.

Step 4: Identify the Academic and Support Units That Participate in These Activities

The next step in building your Economic Model is to identify the organizational units that are involved in the activities and tasks.

Documenting the organizational units involved most directly is only the first step. Do not miss units and individuals involved in supporting roles. For example, which units and individuals help the faculty member use technology in a course – training? Instructional development? Moving equipment to classrooms? Repairing projectors? Solving problems of connectivity for students? Purchasing software?

STEP 5: IDENTIFY THE RESOURCES THESE UNITS CONSUME IN THEIR ACTIVITIES

Your next step is to identify the time, money, space, equipment, and other resources these units and individuals consumed to produce your output. Your institutional financial records system office may be able to provide budgeted and actual expenditure data for each account maintained by a unit. However, accounts do not always translate easily into a specific activity such as course development. You will need to cut and paste pieces of these resources into your model, using different weighting or allocation schemes.

Obtaining data about how much time people spend on each activity and task (workload effort) is one of the more challenging elements of building a cost model. Not only is it quite difficult to estimate time spent on a task, even when keeping an hourly log (which almost no one is willing or able to do), faculty and staff may be wary of reporting their time spent, because they may fear the consequences of the study. (That is a major reason why many good studies seem to be self-studies: individuals and organizations who want this data so that they can make their own work more successful and less stressful on time and budgets.) Having reasonably accurate estimates of time spent on key tasks is essential to your model, so you will need to recruit faculty and staff cooperation tactfully.

Estimating Time

The IUPUI and RIT implementations of the Economic Model each involved a survey of faculty. RIT supplemented this with interviews.

At George Mason University, the cost analysis methodology involves faculty interviews as well as administering a mini-version of the National Study of Postsecondary Faculty (NSOPF) survey. In the end, though, the faculty workload data were suspect. In the future, it is recommend that faculty be asked to maintain daily activity logs.

The LTTS project developed time sheets for project to help gather data; over the years, shifts in these sheets, and how they were used, reflected the changing priorities of the project.

When faculty and staff own the process, they are much more likely to be committed to providing accurate data and, ultimately, to helping implement recommendations. We believe that studies like this should be designed to reduce the chances of burnout, to make careers more satisfying, and to make sure that when resources are really needed, they are available. It is important to assure those estimating how they spend their time that they are contributing to an ongoing effort to make their own work more productive and satisfying, and support procedures more efficiently. Emphasize that the data are not being used to show whether they are doing their work "correctly" or spending the "right" amount of time on different tasks. Representatives of respondent groups ought to be involved in the study design. They should be able to review and suggest changes to a report about their activity.

Once time estimates have been collected, the next step is to estimate the cost of an hour of time--a difficult task. Some models derive hourly rates from annual salaries and the assumption that the staff works 40-hour weeks. Others start with estimates of how many hours the staff really do work a week (50? 60?). Either way can lead to paradoxical results if one equates cost and value. Consider two classes of employee that work for the same annual salary. One group works a 40-hour week, the other a 55-hour week.

- If hourly rates are defined using the assumption that everyone works a 40-hour week, then the '55 hour' group can generate cost estimates that exceed their annual salaries, if one counts all 55 hours of activities.
- If, on the other hand, the model derives a different hourly rate for the '55 hour week' group, then the model seems to imply that they are of less value because their 'hourly rate' (a fiction of the model) is less.

Workload Matrix (sheet 2)

Time Spent	Faculty # 1 Time	Teaching Asst. #1 Time	Staff #1 Time	Staff #2 Time
Total annual hours (2,080) for 12 months at 40 hours per week (staff only)		A		
Total annual hours based on contract (faculty only)	A			
Activity 1 Hours				
Task A				
Task B				
Task C				
Total	**B**	**B**		
Activity 2 Hours				
Task A				
Task B				
Task C				
Task D				
Total	**C**	**C**		
Total Activity Hours	D=B+C	D=B+C		
Activity hours as percent of annual hours	E=D/A			

In order to keep our model simple, we classify costs under three broad categories: (1) compensation; (2) direct, non-personnel expenses; and (3) hidden costs.

Compensation includes employee salaries and all employer-paid benefits such as retirement, FICA, and health insurance. The list of faculty and staff that helped produce an output is used to identify their salaries and benefits. The result is total compensation, which is then calculated against the percent of total workload spent on the activities being evaluated.

Direct, non-personnel services include all typical academic and administrative office expenditures such as travel, equipment, copying, software, and supplies. These expenses are considered direct expenditures because they are specifically related to the output being evaluated. For example, the technology course involves the purchase of software and the traditional course requires copying. Or, this person may attend a conference to help develop the skills needed to create online content. Departmental expenditures for non-personnel services for administrative overhead are not considered separately, but fall under the category of hidden costs.

Hidden costs, while often not identified in budgets, still effect how much it costs to offer an innovation with technology. They include, but are not limited to, administrative overhead, depreciation, building costs, and utilities. Part III of this *Handbook* will discuss in more depth how to incorporate hidden costs into your Economic Model.

For now, there are three types of hidden costs to consider: (1) administrative overhead; (2) physical plant; and (3) activity-based costs related to a specific course, but that will not be found in a departmental budgeting system.

Administrative overhead is not addressed in the sample model, but is discussed in the report of the cost methodology used by George Mason University. It may not be important to address administrative overhead at this point, unless there is good reason to believe that departmental/unit overhead will vary widely with different units and activities in the model.

The example of hidden costs discussed in Part III includes space and equipment. Other hidden, activity-based costs that might be associated with the course could include purchasing, setting up, and maintaining the hardware and software for the web server on which the online materials are housed.

Equipment Matrix (sheet 3)

Computer	Trad. Course	Tech. Course
Computer expenditures		A
Depreciation schedule/years		B
Depreciation per annual year		C=A/B
Depreciation per semester		D=D/2
Utilization for Course		E%
Utilization Cost		F=D*E

As you create your model, you will need to move through layers of these worksheets. Each time you examine a cost area more closely, such as equipment, you may find that it is difficult to fit it into an existing worksheet. Just create a new table for equipment, listing all hardware and who is using it. You may also want to measure the hours of usage of the equipment. How much of this usage is devoted to the activity you are evaluating? How should the equipment cost be amortized? This approach allows you to prorate equipment costs

Determine which accounts you need to examine

Most financial systems in higher education involve thousands of account structures. An academic department usually has a general account to which expenditures and compensation are charged, as well as separate accounts for sponsored research. In order to identify all costs, you may need to examine several accounts. These are usually broken down into categories of expenditures, sometimes called object codes, such as travel, publications, and equipment. Individual purchases or transactions are combined into object codes, based on budget, reporting, and audit requirements.

At WSU and RIT, team members found it difficult to identify all costs because the university had no central repository for the kinds of data for which the team was looking. In addition, WSU team members found it hard to explain to administrators that they were seeking information about monies drawn from operating funds rather than capital funds. The team members are hopeful that with more experience they will find it easier to collect cost data.

GMU was able to use data from its Data Warehouse to document direct expenditures and compensation at the unit level. These data were shared with faculty as part of the initial discussion of costs. Financial data were available by account at the object code level. During the faculty interviews, it became clear that individual faculty members paid a large part of the cost of developing the technology themselves, without reimbursement from their departments.

STEP 6: CALCULATE ACTIVITY COSTS

You have identified your resource concerns, general and specific outputs, activities, and resources. You have identified any metrics by which you might further quantify costs and you understand the relationships between variables in terms of cost drivers. Now you are ready to calculate the costs of the various activities and tasks involved in producing your output. A simple spreadsheet model to account for several activities might look like Sheet 4, with breakouts for each type of cost and for each person involved in the activity.

Cost Matrix (sheet 4)

Activity-based costs	Faculty #1	Teaching Asst. #1	Staff #1	Staff #2	Total
Salaries					A
Benefits (24%)					B=A*.24
Salaries and Benefits					C=A+B
Activity hours as percent of annual hours					D (from worksheet)
Total Activity Compensation					E=C*D
Activity 1 hours					F (from worksheet)
Activity 1 portion of compensation					G=(F/D)*E
Activity 2 hours					H (from worksheet)
Activity 2 portion of compensation					I=(H/D)*E
Activity 3 hours					J (from worksheet)
Activity 3 portion of compensation					K=(J/D)*E
Non-Personnel Services					
Travel					
Photo copying					
Phone					
Equipment					
Software					
NPS total					L
Hidden Costs					
Space					
Equipment Depreciation					
Hidden costs total					M
Total Costs					N=C+L+M

STEP 7: TALLY THE COSTS OF ALL ACTIVITIES TO ARRIVE AT YOUR OUTPUT COSTS

The aggregated spreadsheet for this example would look like this:

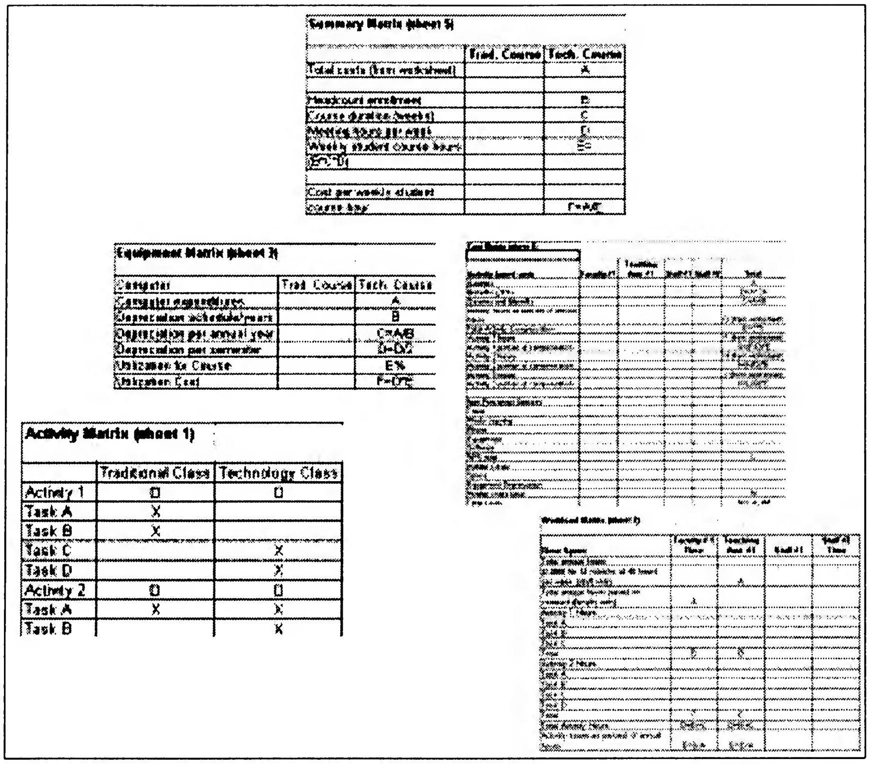
Summary Matrix (sheet 5)

	Trad. Course	**Tech. Course**	**Equation**
Total costs (from worksheet)			A
Headcount enrollment			B
Course duration (weeks)			C
Meeting hours per week			D
Weekly student course hours			E= (B*C*D)
Cost per weekly student course hour			F=A/E

Think of your Economic Model as a pyramid constructed of blocks. Each block is a spreadsheet. The top block, or highest-level spreadsheet, contains data about the total cost per output for all activities and tasks. The base of the pyramid is made up of many spreadsheets, each of which analyzes costs for one activity and its related tasks. As you work your way up the pyramid, you feed or link subtotals from the lower spreadsheets into those at a next higher level. This results in a gradual aggregation or tallying of costs, as illustrated in Figure 1.

Figure 1

Linkage of data from lower details matrices up to top-level summary matrix.



In the example of costs per weekly student course hour for the traditional and technology sections of Sociology 101, possible cost drivers (factors with the greatest influence on total costs) include student enrollment, faculty workload, and other resources consumed. Each driver can be tweaked in the model to ask "what if" questions. Build your model so that you can change the cost drivers and study the influence of these changes on cost/per student and cost/course. For example, you might want to stay the effect of increasing enrollment for the technology course. For the IUPUI model that examined retention, the evaluators looked at the effect of increasing retention on costs.

In the next section, we will fill in the blanks of our sample model, showing more detail about each of the worksheets is designed and integrated.

PART III: THE SAMPLE MODEL

For the purpose of this *Handbook*, we developed a fully functional, sample model. Here is the story behind the model:

At a hypothetical medium-sized institution with 20,000 students, there is a mix of doctoral and masters programs in arts and sciences. There is no Ph.D. program in sociology, but numerous undergraduate and master's students. In other institutions this size, Ph.D. students are used to help to teach introductory courses. Therefore, the department has had to rely on full-time, ranked faculty to teach these classes. While it has tried to use more part-time faculty, it takes a lot of work by the chair to hire and monitor these adjuncts. In addition, there is a lot of turnover among the young, recent Ph.D., part-time faculty members because they move away to take better jobs.

The dean and department chair want to reduce the amount of full-time faculty time involved in teaching introductory sociology courses. This will keep the faculty happy, letting them concentrate more on research and working with masters students; but how will the department be able to keep up with student demand? The idea of using technology and serving more students has been discussed. The administration would like to know what it costs to teach introductory sociology the old way versus using Internet technology? Could this type of course accommodate more students and an increased faculty to student ratio?

Since there is vocal discussion among faculty about whether online courses are as academically rigorous as their traditional counterparts, the chair does not want to offer the course entirely online. Nor does she have much money to spend on developing course content for the web. A new assistant professor is interested in teaching the technology course. A tenured, associate professor teaches the traditional counterpart.

The resource question of interest is:

What is the difference in total cost per section between a traditional section of Sociology 101 that meets twice a week for fifteen weeks and a section that meets only a few times and does most of its work on the Internet? What is the total cost per weekly student course hour? A lower cost in each measure will be interpreted as better.

The model that is presented was designed to compare this specific set of courses and the results are only useful for this one institution at a specific point in time.

The activity matrix documents the differences and overlap in activities between the traditional and non-traditional sections. While the traditional instructor must be physically present in the classroom and maintain office hours, the online instructor trades these duties for those of setting up the website, using Cold Fusion software to develop online testing, monitoring the listserv, and responding to student email.

One of the most critical steps in cost analysis involves the process of defining activities and breaking these up into tasks. This also helps to identify specific purchases or additional human resources used. In the technology course, there is an additional task that requires purchasing Cold Fusion software.

Note from the activity matrix that a lot more time is spent in the technology class on preparing materials. In the future, while there will be some new electronic material and updating necessary, the total amount of time spent by faculty may actually decline. This is a cost driver to be tweaked with future iterations of the model.

Activity-Task Matrix (sheet 1)

List of Tasks/Activities	Traditional Class	Faculty Hours	Technology Class	Faculty Hours	Equation
Activity 1 – Prepare Course					
A. Coordinate with dept. chair	X	1	X	1	
B. Create syllabus	X	4	X	4	
C. Prepare electronic version			X	20	
D. Update course materials	X	8	X	8	
E. Develop website			X	40	
F. Find/maintain web server			X	6	
G. Develop online materials			X	80	
H. Develop quizzes	X	8	X	8	
I. Learn Cold Fusion software			X	15	
J. Build interactive quizzes with Cold Fusion software			X	15	
K. Develop graphics	X	8	X	8	
L. Put graphics online			X	2	
M. Set up listserv			X	2	
N. Set up email filters for class			X	2	
Total for Activity 1		*29*		*211*	*A*
Activity 2 – Teach Course					
A. Teach class	15 weeks x 2 meetings & 1.5 hrs each	45	1 meeting for start, mid-term, and final exam	6	
B. Office hours	6 hrs per week x 15 weeks	90		0	
C. Monitor enrollment	X	2	X	2	
D. Monitor listserv			X	30	
E. Respond to student email			X	30	
F. Respond to student phone calls	X	2	X	8	
Total for Activity 2		*139*		*75*	*B*
Activity 3 – Grading					
A. Administer quizzes	X	2			
B. Grade quizzes	X	2			
C. Report quiz grades	X	2			
D. Report quiz grades online			X	1	
E. Administer exams	X	2	X	2	
F. Grade exams	X	8	X	8	
G. Report exam grades	X	1	X	1	
Total for Activity 3		*17*		*12*	*C*
TOTAL for all Activities (A+B+C)		185		298	D=A+B+C

Better understanding of faculty workload issues is another byproduct of this cost analysis process. The following chart documents overall faculty effort. Both classes have a teaching assistant. While the traditional class uses the teaching assistant to grade quizzes and monitor enrollment, the technology class uses her to put quiz material online. For the traditional class, a departmental program support technician is used to distribute grade and enrollment reports and to answer general student questions before the course starts. The technology class requires staff help from two people in academic computing support to set up space, install Cold Fusion, and monitor security on a PC with NT Server running the web server software.

Faculty Workload Matrix (sheet 2)

Traditional Class	Total Hours
Faculty #1	185
Teaching Assistant #1	150
Staff #1 (office clerical)	10
Technology Class	
Faculty #1	298
Teaching Assistant #1	10
Staff #1 (computer support center)	20
Staff #2 (computer support center)	20

Comparing the two sections, the faculty member using technology spent more time on developing the online class and less time on direct teaching. Overall, the faculty data show that this person spent 248 hours on specific course-related tasks, compared to the 185 worked by the other faculty member. An activity log may need to be maintained daily by faculty and staff during several weeks of the semester to capture all hours of faculty and staff time spent on a project. This would allow the model user to better document the number of hours spent on each task.

The first resource matrix builds upon the faculty workload data.

Resource Matrix #1 (sheet 3)

Faculty Costs	**Trad. Faculty**	**Tech. Faculty**	**Equation**
Total 9 month salary	55,000	40,000	A
Benefits (university contribution)	24%	24%	B
Benefits amount	13,200	9,600	C=A*B
Total compensation	68,200	49,600	D
Hours worked per week	50	60	E
Total 9 month hours worked (9 months of 4 weeks)	1800	2,160	F=E*36
Hours spent on class activities	185	298	G
Percent for section	10.28%	13.80%	H=G/F
Faculty Costs per section	$7,009	$6,843	I=H*D
Other Personnel Costs	**Trad. Course**	**Tech. Course**	**Equation**
Teaching Assistants (each paid $4,000 per semester, assisting with 4 courses, of which this is 1).	$1,000	$1,000	A=(4,000/4)
Staff 1 Time	10 hrs	20 hrs	B
% Annual Time (2080 hrs)	0.48%	0.96%	C=B/2080
Salary	25,000	35,000	D
Benefits (24%)	6,000	8,400	E=D*.24
Salary/Benefits Total	31,000	43,400	F=D+E
Cost per section	$149	$417	G=F*C
Staff 2 Time	0	20 hrs	H
% Annual Time (2000 hrs)	0.00%	0.96%	I=H/2000
Salary	0	35,000	J
Benefits @ 24%	0	8,400	K=J*.24
Salary/Benefits Total	0	43,400	L=K+J
Cost per section	$0	$417	M=L*I
Total Other Personnel Costs	$1,149	$1,835	N=(A+G+M)
Total Personnel Costs	$8,158	$8,678	

When all personnel costs are accounted for, the technology course takes more faculty time and relies on computing staff help to develop the web server and listserv. The tenured faculty member costs more than the new assistant professor (who is eager to use technology and hopefully become established).

Departmental costs are broken out for those non-personnel services that can be directly attributed to each section. The traditional section involved some photocopying. For the technology course, the instructor purchased a software package for building websites and a digital drawing pad for creating graphics. Since the drawing pad is low cost, it will not be depreciated like other equipment.

Resource Matrix #2 (sheet 4)

Sociology Department account #1-67382	Trad. Course	Tech. Course	Equation
Total Compensation	$8,158	$8,678	A
Direct Non-Personnel Services			
Photo copying	100		B
Drawing Pad		150	C
Software		500	D
NPS subtotal	100	650	E=B+C+D
Total Direct Costs	$8,258	$9,328	F=A+E

Hidden costs. One of the largest areas of hidden costs is space. Both classes are dependent on some number of meetings in a physical classroom. How should this use of the building be accounted for? Should building maintenance and depreciation be built into the equation?

The traditional analysis of classroom utilization sometimes fails to account for creative use of space and for the true cost of this precious capital outlay resource. The National Commission report adopted a model by Gordon Winston that incorporates the concept of "opportunity costs" (Harvey et al, 1998). Opportunity costs estimate the value of missed "opportunities" in which the institution could have rented the space at fair market value.

If you decide to estimate space costs, there are a number of sources to help you calculate the cost-per-square-foot figure. These include projected annual costs for new construction, the cost of renting comparable space in a commercial facility, or figures derived from capital outlay financial records. You will need to decide what source is most appropriate for your situation. The Gordon Winston model also includes a simple method for estimating building depreciation costs, estimated at 2.5%. The annual 2.5% depreciation rate is applied to the replacement or market value of buildings.

To allocate the building cost for the example model, we need a supplemental worksheet. Fair market rental prices are used for the model. Data on actual replacement costs for the building and depreciation are not needed, since these are already included in the commercial rental price.

Space Matrix (sheet 5)

Space	Trad. Course	Tech. Course	Equation
Cost per sq. foot	$2	$2	A
Number of months rented	4	4	B
Semester cost per sq. foot	$8	$8	C=A*B
# Sq. feet	1,000	1,000	D
Semester cost for rental	$8,000	$8,000	E
# Weeks of class meetings	30	3	F
# Hours per meeting	1.5	3	G
# Class hours in room	45	9	H=F*G
All class hours meeting in room (from schedule)	225	225	I
% Utilization	20.0%	4.0%	J=H/I
Cost for the section	$1,600	$320	K=J*E

First, we take the cost-per-square-foot figure and multiply it by the room's number of square feet to arrive at the total opportunity cost of the room, prorated by the number of months of the rental (four since it is needed for a semester of 15 weeks). Next, we look at the use of the room. Both courses meet in the same room. The traditional course meets two times a week, ninety minutes a day, for fifteen weeks. The 30 class sessions take up 20% of the room's utilization, calculated by listing all classes that meet in the room and totaling the hours they meet. The technology course only meets three days out of the entire fifteen weeks, or four percent of the room's total space utilization.

The registrar's staff that schedules rooms produces, as part of the scheduling process, a series of reports with course data by room, broken out by time and day of week. You may want to request a copy of these reports to help build your space matrix. These data should be verified by talking with the faculty and staff members involved in the activities under study. Many last minute room changes never show up in the room scheduling system.

Another area of hidden costs is depreciation of equipment. In this case, the only equipment consists of the Windows 2000 Server computer which houses the web server and Cold Fusion application server and the computer used by the technology course faculty member to develop online materials. The traditional course's faculty member has a computer, but does not use it for the course, only to check email.

To calculate equipment depreciation, the purchase price of the computers is amortized over their lifetime and adjusted based on an appropriate amortization schedule. This spreadsheet might look as follows:

Equipment Matrix (sheet 6)

Computer	Trad. Course	Tech. Course	Equation
Pentium 200 w/ 64 MB Ram and 4 GB hard disk. Purchased 1997	0	2,000	A
Utilization for Course	0	75%	B
Utilization Cost	0	1,500	C=A*B
Dual Pentium II 350 w/ 256 MB Ram, SCSI, RAID 5, NT Server	0	8,000	D
Utilization for Course	0	10%	E
Utilization Cost	0	800	F=D*E
Total Utilization Cost	0	2,300	G=C+F
Lifespan	0	5 years	H
Depreciation per acad. Year	0	460	I=G/H
Depreciation per semester	0	230	J=I/2

Now that the various building blocks of the cost model have been assembled, the key cost components need to be aggregated into a single worksheet.

Summary Matrix (sheet 7)

Subtotals	Trad. Course	Tech. Course	Equation
Compensation & Direct NPS Costs	$8,258	$9,328	A
Space Opportunity Cost	1,600	320	B
Computer depreciation	0	230	C
Total Costs per Course	$9,858	$9,878	D=A+B+C
Total Student Headcount	35	100	E
Total weekly student course hours (3 hours per student per week x 15 weeks = 45 weekly hours per student)	1,575	4,500	F=E*(45)
Cost per weekly course hour	$6.26	$2.20	G=D/F

<u>Cost Drivers.</u> What are the cost drivers associated with this sample model? Let us look closer at the variables that may change over time. These include the number of hours spent by faculty on each activity, faculty compensation, student enrollment, computer use, space use, and the performance measure calculation of weekly student course hours.

What are some of the ways in which the model can be tweaked by the sociology department chair and others to examine cost constraints and issues?

- In the future, the number of hours spent on the activity of online content development will decrease. If this time is not put into another activity, the overall number of hours spent by faculty will decrease. This will lower the portion of faculty compensation used and therefore decrease costs.
- Instead of using a tenured associate professor who is paid $55,000 a year, the chair can assign the traditional course to another new assistant professor to teach at $40,000. This will decrease the faculty costs of the traditional course by $15,000 (27.3%).
- The enrollment of the technology course could be increased with the assumptions that the faculty could use the listserv and email to handle more students and that the online materials are already created. This would increase the number of weekly student course hours and decrease the performance measures results of cost per weekly student course hour.
- It is possible to use an existing computer, therefore decreasing depreciation costs. If the instructor teaching the traditional course gets a computer and uses it for course email, these costs go up.
- If the technology course meets more often during the semester, the space costs go up.
- In the future, computer center support staff may not be needed for the technology course. This would decrease the personnel costs by $868.
- The Cold Fusion software and drawing pad will not be purchased again. Next time the course is offered, there will be less spent on direct, non-personnel services.

FINDINGS

Based on the structure of the example model and the details of the matrices, we can highlight some of the model's findings.

In terms of the first performance measure, the cost per course for the traditional course ($9,858) is almost equal to that of the technology course ($9,878). The faculty member's time in the technology course is merely displaced, from time spent in the classroom to time spent monitoring the listserv, updating online content, and responding to emails. However, when cost per weekly student course hour is used as the performance measure, then the larger headcount enrollment that may be accommodated with the online course significantly reduces the section cost. The online cost per weekly

course hour is almost a third of the traditional course, $2.20 instead of $6.26 per weekly student course hour.

Assumptions about the appropriateness of increasing enrollments with technology courses need to be raised. The literature on learning styles and philosophy of education has much to say about the efficacy of serving more students with technology. This is one reason the Flashlight Inventory is so useful, for it gives institutions a complete set of tools for examining critical questions about the cost-effective and pedagogically sound use of technology.

<u>Variation in methodology.</u> You will note that there are many possible variations within the models described in this *Handbook*. When you report the findings of your Economic Model, it is essential to be explicit in describing what factors or "tweaks" affected your costs. Faculty workload is one component of the model that will vary widely, depending on the circumstances and on the way in which these data are collected.

It is important to pick apart your assumptions about the model, because others will certainly do this, so be prepared for their ideas.

<u>Variation in costs.</u> Once you build your model, choose the outputs and measures, and gather the data, you may or may not be surprised by the results. If you are surprised, do not take the data at face value. Perhaps there is an error in the model, or odd data shows up for one year, or you are using an estimated cost driver. Be sure to check all of the cost drivers in the model to verify that they are having the intended effect on the equations you designed. Run the model with another year's worth of data and see if you come up with the same results. If they are different, ask yourself why.

<u>Other benefits of modeling.</u> There is a byproduct to breaking down these complex activities into tasks - documentation of the steps for future innovations with technology. The task lists become a flowchart for replicating the use of technology, using the same types of steps for each subsequent innovation and its use. If someone is interested in a specific type of technology, the list of activities and tasks, along with previous faculty workload data is an invaluable blueprint that will help save time and money and prevent reinvention of the wheel.

The information gathered about specific faculty, staff, and student workload, through surveys, interviews, or methods designed to document time on task, is a valuable tool as well. This helps administrators and faculty better understand faculty roles and the tensions of competing priorities for their time. As the dominant expenditure in higher education, personnel costs need to be questioned as part of any modeling of resource use. The faculty workload data gathered with this process are important, in and of themselves, for decision-making about resources.

Similarly, the work done in modeling on defining performance measures for outputs is another helpful by-product of cost analysis. Many institutions are engaged in a broad dialogue about performance indicators relevant to their mission. These measures often boil down to ways to measure costs, efficiency, effectiveness, and quality – all variables that can be incorporated into your modeling.

DEVELOPING THE MODELING PROCESS

In writing this book, we had to decide between:

a) developing a simple (and perhaps simplistic) model that would be relatively easy to understand and more flexible for a variety of studies, or

b) a more elaborate model that would include the subtleties but that might be harder for novice model builders to understand and that would have focused on just one type of cost study.

We chose the former course.

One important component of cost models that is not explored in this *Handbook* is revenue, and technology use can sometimes increase revenue (e.g., additional enrollment-related revenue, grants for innovation). Revenues are considered, however, in the George Mason case study in Appendix B. How much money was generated by the technology innovation you are evaluating? It appears on the surface that the technology course, which taught 100 students, generated more revenue. This basic enrollment equation is not always true. Financial aid, especially the institutional practice of net tuition discounting, needs to be examined in order to make these kinds of revenue estimates. As the IUPUI case study points out, there is also a revenue factor implied when you use performance measures related to retention and attrition. Your school saves money by keeping students enrolled. There is a tremendous cost to students as well for dropping out, effecting long-term income potential (another hidden revenue generator).

There may be more hidden costs that the model does not describe which you will discover over time For example, in working with some online course providers to develop content, there is a fee per student charged by the vendor to the school. The

school does not have to staff and support content development because this has been outsourced or privatized. However, the revenue loss may be temporary, as the vendor may be able to turn around and market the course to a larger audience, offsetting the initial high development cost with royalties to the institution.

One exciting possibility is to use "cost" models to explore ways to reduce stress in jobs and make activities more fulfilling for the people who do the work. So far, many people see cost models as a threat, and (often) rightly so. Traditional cost models treat working time as a cost, something to be reduced in order to keep students and alumni out of debt while reducing demands on taxpayers and donors. That is an important thing to do, in an era when more people need to learn while fewer people (per learner) are available to pay taxes and give gifts to colleges. At the same time, however, most staff members have full-time jobs. From their point of view, the cost model appears to have only one potential impact if its goal is 'time saving': do their jobs continue to exist or are they to be eliminated? We suggest that it is more constructive, both for the purposes of cost savings and for the staff involved, if models are designed in order to help work processes become more effective, efficient, and fulfilling. The University of Pennsylvania case study on engineering laboratories in Appendix II is a step in this direction. Pope and Anderson describe a modeling process that helped reduce time spent by faculty and staff on burdensome activities such as grading, record keeping, and training in how to operate lab equipment while maintaining time spent helping students learn. Future models ought to focus on reorganizing activity so staff members can see that their work is successful, is efficient in its use of the time, and is less of a strain on budgets. If you do such a study, or know of one, we hope you will suggest that it be included in the next edition of this *Handbook*!

CONCLUSION

This *Handbook* has presented an Economic Model methodology for conducting cost assessment studies of technology in teaching and learning. Part I explored the general approach to cost analysis, including the classic NACUBO indirect cost recovery approach and recent work funded by the Andrew W. Mellon Foundation, the Annenberg/CPB Project, the Alfred P. Sloan Foundation, and the Pew Charitable Trust. The organizational constraints and issues that face institutions when they initiate this type of cost study were highlighted, such as the necessity for a team process. Part II outlined the basic building blocks for creating this kind of model. Inputs, units, and resources are used to calculate outputs and performance measures to answer a set of resource questions. In part III, a sample model was analyzed in detail with specific worksheets that document activities and tasks, workload, compensation, direct non-personnel costs, and hidden costs such as equipment and space.

The methodologies listed here are relatively easy to apply, although the data are sometimes difficult to gather. While modeling may appear to provide answers for the questions you are interested in, there are always things to pick apart or tweak. The dialogue that follows at your institution about the model and its cost evaluation is just as important as the results, if not more so. Be prepared for and welcome criticism. It is all part of the change process for innovation. It is critical that institutions begin to discuss the issue of costs related to technology and to address resource concerns in this way. This *Handbook* is a valuable first step in this process.

This Flashlight Cost Analysis *Handbook* will continue to evolve. The authors welcome hearing from you about your own case studies, including how you developed your methodology, any results you wish to share, and how the results have influenced decision-making. Look for the next edition of this *Handbook*, as the authors continue learning with you about modeling resource use in teaching and learning with technology.

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APPENDIX A: GLOSSARY OF TERMS

GLOSSARY

Activity – Specific jobs, roles, duties, or functions performed by individuals and/or units. Examples include course preparation, teaching, and enrollment management.

Activity-Based Costing (ABC) – A method of evaluating costs by the basic types of activities involved. These activities may cut across organizational boundaries and include many types of expenditures, including some hidden expenses that do not normally appear on operating budgets.

Cost drivers – Variables in a model that have a substantial impact on total costs. Examples include average enrollment per course, the number of hours typically spent on an activity, and the amount of space needed for each additional unit of activity. Altering these cost drivers in a model is one way of exploring strategies for reducing the cost of achieving a particular level of performance (e.g., changing the assumption about number of dropouts from a course and the influence of this cost driver on cost per student completing the course).

Macro-costing – The process of examining aggregate costs at the easiest-identified unit level. The standard accounting system structure is used, as in indirect cost recovery models. A variety of complex allocation schemes is possible to allocate different tiers of costs. This methodology lets the user develop cost-sharing calculations for hidden costs such as administrative overhead at the department, dean, and university-wide level; student services; utilities; and physical plant.

Metric – A way of measuring an activity, task, or specific cost.

Micro-costing – A way to evaluate costing from the ground up by examining any and all costs associated with a project or program (cost center or focus). The idea is to document the full cost of the activity or process. Activity-based costing may be used as part of this process.

Performance measure – The specific output analyzed by a model. It measures a general output, such as producing a CD-ROM. An example might be the number of students who use the CD. Other measures used in this *Handbook* include weekly student course hours

Responsibility Centered Management – A way to promote responsible management practices by evaluating and assessing costs and programs. Activity-based costing is often used as part of this process.

Task – Each activity can be broken down into component activities ("tasks"). Examples of tasks that are part of the activity of course preparation might include reviewing the syllabus, selecting readings, and revising the sequence of materials to meet course objectives.

Weekly student course hour – An example of a performance measure used in the *Handbook*'s example model. This calculates the number of hours in which students are enrolled to "sit" in a course or activity. For a course, this is often three hours per week for fifteen weeks. This differs from student credit hour (SCH), which is the number of credits awarded for passing a course.

APPENDIX B: SEVEN CASE STUDIES

CASE STUDY 1:

INDIANA UNIVERSITY PURDUE UNIVERSITY INDIANAPOLIS
COST IMPLICATIONS OF TECHNOLOGY USE IN THE IUPUI ENGLISH DEPARTMENT'S CORE WRITING CURRICULUM

IUPUI Economic Model Office
Indiana University Purdue University Indianapolis
24 June 1996

Revised June 1999 with approval for the purposes of this handbook

Abstract: *This study of costs is a component of the Annenberg/CPB Flashlight Program in which IUPUI has joined four other institutions (Washington State University, Rochester Institute of Technology, The University of Maine, and Maricopa Community Colleges) for the development of a set of evaluative instruments which educational institutions can use to monitor and assess their usage of technology in instruction.*

BACKGROUND

In March 1995, the Economic Model Office at IUPUI undertook a comparative study of the costs associated with providing introductory instruction in English composition, given two different instructional formats:

- utilizing a traditional classroom;
- utilizing networked computer classroom (NCC) instruction in a modified classroom containing a series of networked computer workstations.

Two key issues are the focus of this cost analysis of the English composition courses:

1. Does it appear to be more cost effective (in operating costs) to offer a program where students participate over networks than one where students come to traditional university facilities for classes?
2. If the university's use of technology results in increased retention, what are the economic implications of that improvement (if retention data can be obtained from some source)?

Summary of Findings

With the limitations of available data and confounding variables taken into consideration, it was found that for the two courses analyzed it did not appear to be more cost effective to employ technology in the given way to instruction. Further, the application of network technology was associated with a negative effect on retention as defined, and accordingly magnified the negative economic impact.

Description of Study

<u>IUPUI English curriculum core writing courses.</u>

The English department core writing course curriculum was chosen for the comparative cost analysis for the Flashlight Program because the majority of its courses are offered in both traditional and networked computer classroom (NCC) formats, and a sequence of writing courses in these formats was available for study. The composition by computer / networked computer classroom course option has been available since 1986 on a limited basis with one computer classroom, and on an expanded basis with the upgrade and addition of a second computer classroom in 1993. The IUPUI Writing Coordinating Committee assumes an equivalent educational outcome from both instructional formats.

Networked computer classroom courses utilize two classrooms located in Cavanaugh Hall, rooms 323 and 425. Each computer classroom is 672 square feet in a 28' x 24' room. Room 323 has no windows and a blackboard. Room 425 has windows and a dry-erase board. Each computer classroom has 22 student desktop computers connected to two laser printers, an instructor desktop computer connected to an Elmo copy stand camera system, and an overhead video projector. The computer classrooms are <u>not</u>

connected to a local area network beyond the immediate classroom.

The NCC course sections are split into two parts over two class days. One day the class is held in the computer classroom at the desktops and the other day the class is held in a traditional classroom. (Classes meeting once a week have both a traditional classroom and a computer classroom assigned, and move between the two rooms at the instructor's discretion.) This arrangement allows for the doubling of opportunities for students to use computers. Twice as many sections have access to the computer classrooms, but each student has access to computers for only half the class meetings. The computer classrooms are available for individual student use whenever a computer is available, even if another class is being conducted. The computer classrooms always have consultants available for individual assistance when they are open; there is usually an hour or two of open classroom time each week, and any student can drop in and use the computers then.

The traditional instructional format classrooms are typically standard classrooms with blackboards located in both Cavanaugh Hall and the Mary Cable Building. The off-campus courses are conducted throughout the city of Indianapolis – from high school classrooms to shopping mall training rooms. All off-campus English course offerings are taught in the traditional instructional format. Traditional sections typically have a capacity of 27 students.

Data for this study.

Three key data sources from the 1994-95 school/fiscal year were used in this study. Core accounting data regarding resource costs were derived from institutional databases accessed by the university's Financial Information System (FIS). These resource costs included payroll, benefits, supplies, equipment, and other pertinent costs.

The second data source, from which enrollment and retention data was collected, was institutional databases maintained by the Office of Information Management and Institutional Research. While these data were not sufficiently extensive to address a wide range of questions regarding retention, approximate data regarding successful completion of courses were available.

The third data source was the English department faculty. They provided information regarding effort devoted to each of their instructional activities, and assistance in interpreting the findings.

W131 – 231 course selection.

This report will focus on an analysis of the costs associated with two specific courses: W131, Elementary Composition I, and W231, Professional Writing Skills. Given the available data for comparative purposes, these two courses were best suited to this study of costs across the traditional and NCC formats.

Definitions

Given the complex nature of cost issues, a few terms will be defined before presentation of methodology and findings.

Course W131: Elementary Composition I (first year composition)

This course is designed for students to illustrate in portfolios the ability to perform a variety of writing tasks from personal writing to academic writing. The course starts with a list of course goals that drive student's choices about what to include in their portfolios. In their portfolios, students present an argument that justifies the choices made and illustrates their growth as writers.

Course W231: Professional Writing Skills

This course fulfills a second writing class requirement for students in the Schools of Environmental and Public Affairs, Allied Health, Social Work, and Business, among others. With a grade of C or better in W131 or a comparable composition class as a prerequisite, students are introduced to writing in nonacademic settings, particularly report writing. W231 focuses on the development of research skills that will be of value not only in the work place but also in upper-level courses in the student's major area of study.

NCC format of instruction

The networked computer classroom (NCC) instruction format represents the application of technology to instruction using a series of interconnected computers within a particular classroom. This is not an implementation of "distance education", since the students work together at the same time, in the same classroom, using software much like common text editors. Unlike the traditional classroom, however, students compose their work during class and can interactively comment on each others' work in progress.

Note: Within the model, NCC courses are identified as "CAI" (computer assisted instruction).

Operational cost

Operational cost is the total cost of conducting the course. This figure includes all course sections within the given format (NCC or traditional), without regard to the number of students who enroll or complete the course. These costs would be expected to vary among courses and formats as a result of the different activities conducted, differing levels of effort required, and different resources consumed.

Retention

Retention can be defined in a variety of ways. From an institutional perspective, retention can be viewed as completion of a degree. From a student's perspective, it can be viewed as successful completion of academic goals, whether or not they lead to a degree. Persistence, often used interchangeably with retention, is sometimes used to refer to a student completing a course and returning the subsequent semester for more coursework. The definition used in this document was constrained by the availability and use of data for the pilot year of this project. Thus for purposes of this report, retention will be defined as **successful completion of a course**.

Cost per student

Cost per student will be specified in two ways:

- based on students enrolled in a specific course, per instructional format (traditional v. NCC)
- based on students successfully completing a specific course, per instructional format.

The difference in cost per student enrolled and cost per student successfully completing a course will be used as a measure of retention for purposes of this report. The "successful completion" count is defined as the total initial enrollment for the course (by format) minus the drop / withdrawal / fail (DWF) count. The DWF count is derived from institutional data that identifies those students, by course and instructional format, who either:

- complete the course with a grade of C- or less, or
- withdraw prior to completing the course. (This count is taken one week after classes begin to allow for initial volatility in enrollment.)

Methodology

The Economic Model Office at IUPUI utilizes a methodology called activity-based costing to determine total costs associated with the outputs produced by academic departments and administrative support offices. Activity-based costing, unlike traditional fund accounting, traces resource use throughout the analysis of activities required to produce outputs, then to the outputs themselves. The resulting model is not an attempt to determine faculty effectiveness; it is simply a current "picture" of the economic aspects of the subject outputs.

Factors considered

The academic outputs analyzed in this study included the following core writing courses:

- W001 Fundamentals of English (developmental writing)
- W131 Elementary Composition I (first year composition)
- W132 Elementary Composition II (research and argumentation)
- W140 Elementary Composition I / honors (first year composition)
- W150 Elementary Composition II / honors (research and argumentation)
- W231 Professional Writing Skills

***Note:** E010 Access to Writing (pre-developmental writing) – a course within the core writing curriculum – was not considered since it is not offered in the computer classroom format.*

The activities that the faculty members associated with these outcomes include:

- class preparation
- class instruction
- office hours
- assessment
- advising
- orientation / workshops
- other.

Resource costs examined for these activities included:

- faculty effort
- computer classroom consultant effort
- facilities
- computer hardware
- equipment and supplies.

Administrative overhead is not considered in this study, given that it is assumed to be equivalent for both instructional formats. Full-time faculty effort is self-reported data and the cost of their effort is based on this data. It should be noted that people can make mistakes in self-reported data about how they spend their time; therefore accuracy of these data is reviewed by other faculty representatives prior to use of the model. A weighted average method was used to reflect the impact of associate faculty on average course costs. This method derives an average amount of effort as reported in the survey, and applies that figure as weighted by the number of faculty within the specific labor group. (Associate faculty members are part-time, non-tenured instructors who are employed on an as needed basis and paid on a per-course-taught basis.)

Process

In May 1995, about half of the surveyed faculty (18 of 40) completed questionnaires that allowed them to estimate the proportion of their effort during a semester spent in activities associated with the presentation of the six core writing courses. The surveyed faculty members were selected as a representative group of the faculty who teach core writing courses and who were most likely to respond, since the summer period had just begun. There were 77 associate faculty and 19 full-time faculty who taught core writing courses during the period studied. The returned surveys contained responses for W001, W131, W132, and W231, the four courses that most IUPUI students take. Questionnaire responses were combined with financial data on compensation, facilities, supplies and computing costs provided by the school business officer and staff to construct an activity-based costing model. The model presents in detail the faculty effort and other costs associated with each of the core writing courses.

The number of NCC sections has increased each subsequent school year since the inception of NCC, and so affects the data available for analysis. Unfortunately, a cost analysis through the entire curriculum is not possible due to the fact that W132 was not offered in the NCC format during the 1994-95 period. The variation of course formats through the curriculum, coupled with the non-traditional student population, also precluded a complete curriculum analysis. Therefore, the analysis detailed in this report is focused on the courses W131 and W231 because these courses had the greatest amount of useable data and opportunity for application of the cost model methodology.

Findings

Operating costs

The cost model analysis revealed the following operating costs on a per-student basis for the period 1994-95. Component cost contributions are detailed in the model.

The model reveals that for these two courses shown (utilizing traditional and NCC/CAI formats) it does NOT appear to be more cost effective on a cost per student enrolled basis to offer a program where students participate over networked computers in a classroom than one where students come to traditional university facilities for classes.

Completion rate

Retention data regarding successful completion of the two courses reveals a higher successful completion rate for traditional as opposed to NCC/CAI students for both courses. The difference, however, is not statistically significant based on the chi square test.

Retention cost impact

After the completion rates are factored in to determine the cost per student comparison between enrollment and successful completion costs, the NCC format remains more expensive. The CAI version is W131 is 78% more expensive than the traditional in costs per enrolled students and 86% more expensive

in costs per completed student. W231 is even more expensive, 100% more expensive than the traditional in costs per enrolled students and 128% more expensive in costs per completed student.

In summary, the university's use of technology *in these two courses* is associated with decreased retention, thus the economic implications are negative for the two courses studied. Note this study *does not consider whether the high differential costs were inevitable, or simply one of the results of not exploiting the strengths of technology in instruction by reengineering the instructional process.*

"What if" analysis

The value of the cost model architecture is its ability to perform "what if" analysis to assist in decision making. Using the same structures defined above, one might ask what a scenario closer to the "break-even" point (cost neutral) might look like. Accordingly, the following data might be assumed as objectives for program enhancement resulting in more favorable cost outcomes.

First, we might assume total cost and enrollment hold stable, such that the cost per student enrolled may still be higher for the NCC/CAI course.

Secondly, however, we might assume that improving our teaching practices using the NCC/CAI classrooms will result in higher successful completion rates, such that all students enrolled in the NCC/CAI courses successfully complete them.

What then would be the resulting cost impact? Once the completion rates are factored in to determine the cost per student comparison between enrollment and successful completion costs, it becomes clear that increased successful completion rates can have a dramatic cost impact. While not quite matching the cost per student successfully completing the course using the traditional instructional format, the net increase in cost is significantly narrowed over the previous scenario.

One might yet assume some ability to reduce the total cost per course for the NCC/CAI courses, such that the resulting cost per successfully completing student would be lower than that for traditional instruction. In short, **the use of technology and its impact on retention can have favorable effects on net costs** per successfully completed student, even when the total course costs are higher for the courses that use technology.

Limitations

Due to the limitations of available data, it was difficult to assess the relative cost difference of the entire NCC curriculum, other than by specific courses as shown in this report. Likewise, retention data were defined by the completion rate rather than by other potential definitions. IUPUI is making an effort to track individual students through their curriculum more accurately so that these data may be more robust in the future.

Given the different number of students taught in the traditional v. NCC classrooms (NCC classroom sections are limited to 22 students each while traditional sections are limited to 27 students each), it is difficult to make accurate cost comparisons between NCC and traditional instruction on a course section basis. Accordingly, the cost per student comparison is used.

The assignment of faculty to course sections (NCC and traditional) has an important impact on cost since such a high percentage of total course cost (ranging from 62 percent to 90 percent) is attributable to personnel. Faculty exposure to and familiarity with instructing with computers can affect the effort required of them, and therefore cost as well.

Further, the non-random, yet somewhat planned assignment of instructors to sections (with widely varying levels of pay and experience) can also impede the cost comparison effort.

This course level comparison – which acknowledges that W131 NCC instructors were teaching fewer students – suggests that networked computer classroom instruction may result in reductions of instructor effort for some activities. Associate faculty reported spending, on the average, *22 percent fewer hours preparing for class, 13 percent fewer hours teaching the class, and 15 percent fewer hours assessing students' work than their colleagues who taught traditional sections*. These differences might well be attributed to a lighter teaching load in terms of student numbers. NCC instructors reported spending more time in office hours, advising, and orientation/workshops, but still reported devoting six percent fewer total hours to all of their W131-related duties than did those assigned to traditional instruction. It must be noted that the accuracy of data regarding faculty effort devoted to each activity may be questioned since it is self-reported.

Classroom conditions may be another factor confounding the calculation of successful course completion. The Mary Cable Building, where only traditional classroom instruction is available, is in

disrepair and so may affect students' performance as well as retention.

There may also be a confounding factor involving registration. NCC classroom sections are listed first in the schedule of classes. The potential for students to choose the sections they see first may have a self-selection impact on the types of students who ultimately enroll in NCC sections versus traditional sections, therefore affecting the amount of time faculty then spend on their classes.

The registration factor may have a minimal effect on comparative section costs, but its impact on overall curriculum cost may not be trivial – it is believed that some students ignore their writing placement recommendations and enroll at course levels for which they are not prepared. If these students move to the appropriate course level after classes begin, the enrollment in the sections they left obviously will be reduced. The resulting reduction in a section enrollment may have a greater cost impact in the computer classroom section where enrollment is limited. But, the actual number of students who fall in this category is believed to be small and is not recorded.

Observations

The model gives an accurate picture (excluding the allocated Responsibility Center Management charges for the school and administrative overhead) of the *current total costs* of providing writing instruction *with and without computer assistance*. As is often the case in such studies, this picture may raise more questions than it answers. The application of the economic model to the core writing courses of the English department has generated much discussion and many questions. Some of the key issues raised follow.

The English department determines which composition courses are to be offered by computer (NCC format). The decision to eliminate a course section is based on student demand for the curriculum and attempts to maximize the class section capacity. A typical NCC section enrolls a maximum of 22 students (23 students are allowed to enroll with the anticipation that at least one student will drop or withdraw). This maximum is due to the available number of desktop computers. Traditional classroom sections enroll approximately 27 students. If a course section is to be canceled due to low student enrollment, there is a conscious decision to eliminate a traditional classroom section before eliminating a NCC section. A NCC section has never been deleted from the schedule at IUPUI.

The opportunity for a student to take a NCC course section increases as he/she progresses through or places into a higher level in the curriculum. The number of NCC sections in course W001, Fundamentals of English, was eight out of 61 sections in 1994-95. For course W131 there were 57 NCC sections out of 138 total sections offered. For course W231, Professional Writing Skills, there were 32 NCC sections out of 43 sections offered (the only traditional sections were held off-campus).

There is a higher TOTAL cost for W131 NCC course sections because these require contributions by technical staff, investments in hardware and software, as well as some supplies, that are not needed in traditional sections. Essentially, the NCC sections simply apply technology within the constraints of the traditional classroom process. For example, since the computer classroom instructors cannot assess students' writing on-line or obtain access to student work from a remote site, they must incur costs in making paper copies in order to assess their students' work and be on campus to do so (at least to receive the students' work). This raised probably the most critical cost comparison issue within the study:

whether the high differential costs were inevitable, or simply one of the results of not exploiting the strengths of technology in instruction by reengineering the instructional process.

Another worksheet was created to display the per-student costs of traditional and classroom computer sections of the four core writing courses of W001, W131, W132, and W231. The entire curriculum appears to generate revenue for the department and school. The high cost course appears to be the NCC course W001 (a course cost figure was determined using the third-year associate stipend, with the average cost per section for computer cost contributions for W001 – since no surveys were returned for associate faculty in this course). This revenue-generating assessment is based on tuition revenue of $277 per student (three credit hour course @ $92.20 per credit hour). The low cost courses appear to be the traditional sections of the W001 and W131 courses.

Conclusions / Recommendations

Although the application of the Economic Model to the English Department's core writing curriculum did not accomplish as far reaching an analysis as had been considered originally, it did prove its ability to address cost issues relative to the application of technology to instruction. It should be noted that the extent of use of the model will be limited by two factors: a number of confounding variables that ideally would be controlled, and limitations of data available for analysis.

As such, the model could be applied to a wider degree of analysis beyond the basic cost per student comparisons given the following recommendations for control of confounding variables and data collection:

course

- balanced opportunities for registration of students to NCC and traditional formats

instructors

- assignment of faculty controlling for differences in rank
- assignment of faculty using controlled levels of experience
- assignment of faculty using controlled degrees of NCC savvy
- control of the accuracy of faculty reported effort to activity

students

- assessment of students in specified instructional formats
- collection of data by sequenced courses
- collection of thorough retention data
- defined time period of retention

In summary, the use of technology-enhanced instruction makes a difference in cost outcomes, influenced by a number of factors. How these factors are managed will determine the most cost-effective means of instruction. Two key questions follow from this study: are we successfully exploiting technology to its fullest capabilities, and does the impact of technology warrant its investment cost? Both will require consideration of broader Flashlight Program findings before they can be answered satisfactorily.

CASE STUDY 2:

University of Pennsylvania

Reducing the Costs of Laboratory Instruction through the Use of On-Line Laboratory Instruction

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Abstract: *This paper describes a new program for teaching undergraduate laboratories in the School of Engineering and Applied Science at the University of Pennsylvania, based on the idea that laboratories can be taught more efficiently, less expensively, and better with the use of World Wide Web-based technology. This technology is used to help the students prepare themselves before coming to the laboratory by becoming acquainted with the equipment, going through pre-lab exercises and taking pre-lab quizzes, both on the content of the work and on the safety considerations of the laboratory, all through web-based exercises.*

This project demonstrates that web-based teaching tools can both improve the quality of an undergraduate laboratory and, at the same time, reduce costs. The project team accomplished this by making a number of changes in the way laboratory courses are offered:

- *Students prepare for laboratory periods by accessing lab information on the web, beginning the laboratories online before class.*
- *An institution-wide system of on-line grading reduces the time faculty must perform record-keeping activities, and gives students more accurate and timely feedback on performance.*
- *Using software on desktop computers to convert the computers into "virtual instruments" dramatically reduces the cost of laboratory equipment maintenance and replacement.*
- *Increasing the utilization of laboratories significantly reduces the cost of teaching laboratories by reducing the need to construct new laboratory facilities to fulfill laboratory curriculum requirements. This project increased the total usage of the Electrical Engineering laboratory through sharing laboratory modules on the web across engineering departments.*

The Flashlight (activity-based) approach to cost analysis shows that this project reduced the costs of teaching some labs by 30%. With web-based technology, we have improved the students' learning through their pre-laboratory activities. This, in turn, has increased the substantive work that occurs in the actual laboratory session, while reducing the time requirements for the laboratory session. All lab sessions are real, hands-on experiences for students, not simulations.

INTRODUCTION

Engineering and science curricula are extremely expensive to teach because they involve many specialized classroom and laboratory courses. Over the past few decades, partially in response to economic pressures, most engineering schools have come to rely more on lecture-format courses (with more analysis and theory) and less on laboratory-format courses and hands-on experiences. More recently the faculty members of the University of Pennsylvania School of Engineering and Applied Science (SEAS), as well as at many other engineering schools, have begun to re-emphasize laboratory studies, but the costs are still prohibitive. The challenge schools face is how to include high quality, hands-on laboratory courses in the curriculum while reducing their costs. Since the largest single cost in any educational institution is labor, decreasing costs requires reducing the time it takes to deliver the educational product.

Through a project in the School of Engineering and Applied Science, funded by the Andrew W. Mellon Foundation, faculty from four Engineering departments, Bioengineering, Electrical Engineering, Materials Science, and Mechanical Engineering, explored how to use the new information technologies to make laboratory education less expensive and more effective. The goals of this program included: (1) increase the efficiency of using expensive laboratory facilities and instructor time; (2) reduce damage to expensive laboratory equipment; (3) increase the time faculty have available for personal interaction with students in the laboratory; (4) create an educational approach that is portable and can be readily adopted by other institutions; and (5) demonstrate through rigorous assessment that the project has indeed achieved its goals.

The high costs of laboratory teaching arise principally from the costs of personnel, space, and equipment. It simply takes a great deal of time to ensure that experimental stations are maintained in proper working order. An even more important challenge for both faculty and students is that of instructing students at the start of any laboratory session in the safe and proper use of the equipment. The central focus of this project was on developing a way to deliver on-line, apparatus-specific instruction asynchronously along with a competence-check so that students can learn how to operate expensive equipment before coming to the laboratory and also rehearse aspects of the experiments they will carry out.

The result of using this on-line pre-laboratory experience is that less time is required in the laboratory for each class, and therefore both personnel and capital costs of teaching each student are reduced, or conversely, more can be taught in each laboratory, so fewer labs are required for the total curriculum. Equally important, however, is the fact that the quality of the laboratory experience is significantly improved for the student. In addition, having users who are better informed results in less damage to expensive equipment and lower repair and replacement costs. Thus, making multi-media pre-lab modules available, complete with quizzes and tracking, reduces the personnel and capital costs per student while improving the learning environment.

Another reason for the high personnel costs of laboratory experiences relates to the challenge of academic bookkeeping. For example, it is essential to track which students have completed what experiments, whether the resulting reports are graded, and what to do about team members who were absent on the day of the experiment. Instructional staff members usually deal with most of these questions manually, but it commonly happens that, after these routine issues are handled, too little time is left for substantive exchanges between instructor and student about content. As part of this program, SEAS purchased software that includes a grading spreadsheet on which students can electronically access only their own individual records and thereby eliminate much of the routine paperwork. This then allows more time for the kinds of substantive discussion that both students and faculty prefer.

Finally, a comment on the general nature of the problem itself: the best reason for performing a cost analysis like this is to force oneself to truly understand what actually controls the costs of an academic endeavor. Academics tend to ignore the costs of teaching a course, simply because the rigors of the course itself are enough to occupy us. When SEAS first started this exercise at Penn, faculty did not have a clear idea of the costs involved until later in the program when the project team used the Flashlight methodology. Using Flashlight's approach to the modeling of costs helped the team track down the hidden as well as the more obvious expenses of running the laboratories.

Briefly, the team concluded that, because the main costs involved in teaching an undergraduate engineering laboratory are personnel, space, and equipment, then cost reductions must come in those areas. Reducing the costs of other elements, which contribute only a small part to the total costs of running the lab, does not significantly cut the total

cost of the lab. Therefore, the project team focused its efforts on major costs. However, given the nature of our university, the team had no intention of reducing the amount of "face time" our undergraduates have with faculty. To reduce personnel costs while remaining true to our principles, the project had to reduce the time the faculty and staff previously had been compelled to spend on less valuable activities, like handling paper, academic bookkeeping, and competence checks. On-line pre-lab instruction gives students the opportunity to prepare for lab, including the handling of expensive equipment, rehearsing the lab experiment, and taking a pre-lab competence check. Consequently, students are prepared to begin the experiment immediately at the start of the lab session, reducing the time requirements for a typical lab session from three hours to two.

More challenging was the puzzle of how to reduce the costs of space and equipment. One key insight was to realize that at Penn, as at many other institutions, laboratory space and equipment lay idle much of the time. The key lay in increasing laboratory utilization while streamlining laboratory student/faculty "face time" requirements by concentrating "face time" on substantive work. The true costs of the space and equipment can only be reduced through greater utilization of the space and equipment, i.e., by having more courses and more students use the facility per semester. Since many laboratories are highly specialized, greater utilization is difficult – unless faculty members are willing to collaborate on developing shared space and equipment between departments. This requires a cultural change in the faculty, a much more difficult type of change within an institution, without which cost reductions of this nature are impossible.

The Studies

Software Evaluation

One of the team's first efforts was directed at trying to develop an in-house quizzing program customized to our needs for pre-laboratory instruction. However, we soon switched to commercial software packages because it became clear that they are much less expensive to establish and to maintain. During 1999, the project team used both Mallard™ and Blackboard CourseInfo™. We discovered that these packages saved us not only programming time but also the whole process of negotiating and prioritizing the precise needs of faculty members across the school. Packages either provided the services we wanted or they did not. If they did not, we simply considered other packages. We still needed to connect the packages to our local infrastructure, such as pre-loading enrollment information, but we would have done that whether we had used a custom package or a commercial package.

In the sophomore Electrical Circuits and Systems I course, pre-lab material was posted on the web in fall 1999. We measured preparation through 13 weekly quizzes delivered with Blackboard CourseInfo. We surveyed the students about their preparation, and found that 92% agreed or strongly agreed with the statement, "I am better prepared for my labs because I use Blackboard." One student commented, "I probably would not have done the pre-labs if there was not a pre-lab quiz." Another said, "It allows me to see what I've done wrong, which gives me the chance to look through my initial calculations to find my mistake." Yet another student said, "By using the Blackboard system to take the quiz, we don't have to waste time in class taking the quiz." Many students commented on the immediacy of the results, such as, "It is very helpful because we get back our results immediately."

In Electrical Circuits and Systems II, after a written pre-lab assignment was replaced by an online quiz, the Undergraduate Lab Manager reported "no significant difference" between the actual lab performance of students who took the quiz and students the previous semester who did written assignments. However, he said, "I could immediately get feedback. Within two minutes it would tell me how well written our labs were and how well prepared our students were."

Though Mallard has been a very effective teaching tool in Electrical Engineering, it is difficult for instructional staff to learn. Quiz development requires effort from student workers or support staff. On the other hand, Blackboard has less quizzing functionality, but it is much easier to learn. Because of this project in the School of Engineering and Applied Science as well as in the Mellon Writing Project in the School of Arts and Sciences, both funded by the Mellon Foundation, and because of a University committee called "New Tools for Teaching," Blackboard software has been widely adopted throughout Penn. Approximately 1500 students used Blackboard in the fall of 1999. Usage has expanded each semester, and in fall 2001, over 16,000 students in 1400 courses across seven schools at Penn used Blackboard CourseInfo. The largest single course using the program is ECON 1, with enrollment of 900 people.

Based on what the team learned at The TLT Group's Flashlight workshop, "Evaluating Web-based

Based on what the team learned at The TLT Group's Flashlight workshop, "Evaluating Web-based Courses," we did a survey of students about their experiences with Blackboard CourseInfo. We looked for changes in teaching methods made possible at a reasonable cost by the software, and found several. Over 400 students replied to the survey in December 1999. Students reported more prompt feedback, time on task, appeal to different learning styles, active learning and collaborative learning. Through the New Tools for Teaching committee, these results were used as publicity to expand usage of Blackboard.

Specifics of the Effort in an Electrical Engineering Course

On-Line grading systems

Prior to the changes made in laboratory instruction, students arrived at their laboratory sessions with varying degrees of preparedness. On a typical day in a typical lab, approximately 1/3 of the students were fully prepared to do the planned lab experiment, 1/3 were only somewhat prepared, and the remaining 1/3 were not prepared at all. Now, with the pre-lab instruction on the web, instructors are able to motivate students to invest in laboratory preparation by including a pre-lab quiz with the web instruction. Previously, instructional staff manually graded pre-lab assignments and quizzes and returned them to students the following week *after* the laboratory experiment was completed, when the feedback was no longer useful. In fact, we have found that, in general, a remarkably large amount of time was spent in communicating grades to students, checking to see if grades have been changed after exams are re-graded, and in checking the overall accuracy of the grades. By putting all lab and course grades on-line so that the students can see only their own grades, the time spent in these activities has been greatly reduced, and furthermore, the students greatly appreciate the access. (We have found, for example, that they catch a huge number of grading and recording mistakes, most of which were probably missed in the past.) After experimenting with a system developed here at Penn, we finally adopted the Blackboard system. Everyone who has used it is very pleased with it.

Laboratory Equipment

Rendering desktop computers in the laboratory into "virtual instruments" has the greatest potential for future cost savings in this category. Through the use of special software, the computer can be converted into the instrument of choice. For example, the computer could be an oscilloscope, or a digital voltage meter, or a constant voltage power supply, or all three simultaneously. Since every laboratory is now equipped with desktop computers, the only additional requirement is the software to create the virtual instruments. To do this, we purchased a site license for LabVIEW software for the entire School of Engineering, and saved $20,000 for the School, simply because some individual laboratories were already using the software, and the total software expenditure prior to the site license exceeded the cost of the site license by the above amount. The cost of the site license is divided among all classes that use LabView. This is reflected in Table 2-1. However, the $20,000 savings to Penn from the purchase of the LabView site license is additional to the savings in Tables 2-1 and 2-2. Now, as more and more students and faculty become familiar with the software, we are finding that we need not purchase new stand-alone instruments with the same frequency as before and therefore we are saving substantial amounts on equipment purchases. See Table 2-1 for equipment savings in the web-assisted lab vs. the traditional lab.

Activity-Based Cost Analysis

We have analyzed the total costs of teaching our laboratories using the activity-based cost method in an attempt to see if we are, indeed, saving money with the web-based laboratory instruction, and from which specific elements those savings come. We approached it by asking the following specific question: what is the cost difference between a traditional section of Engineering Laboratory, EE 205, which meets once per week for 15 weeks, and a web-assisted section that meets with the same frequency for shorter times but which makes use of web-based tools for teaching, quizzing, instrument simulation, and data analysis?

We approached it based on the assumptions outlined in Table 2-1 and then broke the costs down using the methods from version 1.0 of the Flashlight Handbook, and using the following assumptions when entering the data into the spreadsheets:

1. Salaries are averages for the School of Engineering for the particular category.
2. Hours are estimates, based on discussions with the faculty.

3. Space cost is the average paid by the School of Engineering to the university for the laboratory space we occupy.

4. By ensuring that the students are well prepared to do the laboratory exercises, based on web-based exercises and web-based quizzes performed prior to class, the total time for the lab was reduced from three hours to two hours.

5. Most laboratories now contain personal computers already, so no additional costs are shown for PCs.

TABLE 2-1
Assumptions of the cost analysis
Comparison of course elements for EE 205 in traditional lab vs. web-assisted lab

Traditional Laboratory	Web-Assisted Laboratory
Printed syllabus & laboratory manual	Web-based syllabus & laboratory manual
Taught in conventional laboratory, 3 hours per week	Taught in "augmented conventional" lab, 2 hours per week
Serves 30 students	Same
Laboratory space = 1,000 sq. ft.	Same
Must purchase 15 sets of (2 students/set): + PC - high end, $1,000 + Oscilloscope, $2,100 + Function Generator, $1,400 + Digital Multimeter, $1,000 + Programmable Power Supply, $1,000 Total cost per 2 student/set = $6,500.	Must purchase 15 sets of (2 students/set): + PC - high end, $1,000 + Programmable Power Supply, $1,000 + Interface Board, $500 Total cost per 2 student/set = $2,500. Per class charges + Lab View Software, $250 + Increased server capacity, $200 + Blackboard site license, $250 Total per class charges = $700.
Grades delivered in traditional way, i.e. w/o much comparison with others	On-line grades w/full statistical comparisons
Data handled in traditional way, either hard copy (usually) or floppy.	Data, both numbers & images distributed on net
Requires 1 instructor, 1 technician, & grader	Same (plus additional IT help)
Quizzes (if at all) with paper & pencil.	Quizzes on-line by Blackboard and cover safety, equipment use as well as content
Reports & iterations are hard copy	Final report is hard copy, iterations are on-line

TABLE 2-2

Comparison of cost to teach 30 students in EE 205 in a traditional lab vs. a web-assisted lab

Category	Traditional Lab	Web-Assisted Lab	% Difference Traditional vs. Web
Faculty	$11,781	$8,709	-26%
Lab Coordinator	1,559	2,095	+34%
Teaching Asst./Grader	2,132	1,451	-31%
Staff Asst./CETS	-----	139	+100%
Total Personnel Cost	$15,472	$12,394	-19.8%
Printing	1,200	-----	-100%
Space	1,875	1,250	-33.3%
Equipment/Software 7 year depreciation	5,571	3,100*	-44.3%
Total Lab Cost	$8,646	$ 4,350	-49.6%
Total Cost per 30 student section	$24,118	$16,744	-30.5%

*Transition to virtual instrumentation is not yet complete.

The spreadsheets for the traditional approach to teaching the laboratory and the web- assisted approach are shown in Tables 2-3 and 2-4.

Note that the web-assisted course costs over $7000 less to teach--but there is no one item that accounts for most of the savings. The savings come from less faculty time in the classroom and less time spent on the details of testing, grading and reporting. The other large savings come from lower expenditures for equipment and software in the web-assisted course. The savings in faculty expense may be more ephemeral than real, however. Since faculty teach whole courses, not fractions, the savings shown here may not be realized, unless the faculty can be convinced that this course really takes less effort now, and therefore that faculty member will take on some other additional function for the department, which faculty have done at Penn.

Thus, the savings can be quite substantial, over 30% in this case. But more importantly, we have increased the technology in the course and decreased the cost. This is contrary to the normal trends in our institution.

TABLE 2-3
Spreadsheet for traditional laboratory

Economic Model, comparative cost matrix
EE 205 - Traditional
30 students, 2 sections

		person / unit / org.	Faculty		Technician		Grader(TA)		Staff Asst.(computing)		Printing	Space
			$/hour	57.75	$/hour	27.84	$/hour	12.62	$/hour	27.84		
activity	*task*	*total cost*	hours	cost	hours	cost	hours	cost	hours	cost	cost	cost
Develop Syllabus & Lab. Manual		2,125	24.0	$ 1,386	5.0	$ 139	-	$ -	-	$ -	$ 600	$ -
	Revise course, syllabus	924	16.0	924		-		-	-	-	-	-
	Revise manual, tutorials	601	8.0	462	5.0	139		-		-		
	Print manual and syllabus	600		-		-		-		-	600	
Develop Equipment & Software Needs		86	1.0	$ 58	1.0	$ 28	-	$ -			$ 600	$ -
	Select New Instruments	86	1.0	58	1.0	28	-	-		-		
	Evaluate Computer Needs	0		-		-		-		-		
Purchase & Install new equip. & software		6,295	0.0	$ -	26.0	$ 724	-	$ -	-	$ -	$ -	$ -
	Purchase equipment & supplies	5,850		-	10.0	278		-		-		-
	Install new equipment & train tech.	223		-	8.0	223		-		-		
	Test new equipment	223		-	8.0	223		-		-		
Train Personnel		0	0.0	$ -	0.0	$ -	-	$ -	-	$ -	$ -	$ -
	Train faculty	0		-		-	-	-		-		
Teach the course		8,039	79.0	$ 4,562	24.0	$ 668	74.0	$ 934	-	$ -	$ -	$ 1,875
	Training of students	393	4.0	231	4.0	111	4.0	50		-		
	Oversee activity in lab	6,654	60.0	3,465	20.0	557	60.0	757		-		1,875
	Office hrs, 12 hr/wk, 1 Fac+1 TA	992	15.0	866		-	10.0	126		-		
Testing, grading, reporting		6,973	100.0	$ 5,775	0.0	$ -	95.0	$ 1,198	-	$ -	$ -	$ -
	Prelab Quiz and exercise prep	641	10.0	578		-	5.0	63		-		
	Grading Prelab Quiz and Exercise	2,111	30.0	1,733		-	30.0	378		-		
	Grading laboratory reports	4,222	60.0	3,465		-	60.0	757		-		
		$ 23,519	204.0	$ 11,781	56.0	$ 1,559	169.0	$ 2,132	0.0	$ -	$ 1,200	$ 1,875

TABLE 2-4
Spreadsheet for web-assisted laboratory

Economic Model, comparative cost matrix
EE 205 - WEB Assisted
30 students, 2 sections

	person / unit /org.	Faculty		Technician (Sid)		Grader(TA)		Staff Asst.(CETS)		Printing	Space	Equipment & Software
		$/hour	57.75	$/hour	27.84	$/hour	12.62	$/hour	27.84			
activity *task*	*total cost*	hours	cost	hours	cost	hours	cost	hours	cost	cost	cost	cost
Develop Syllabus & Lab. Manual	**$ 1,870**	29.0	$ 1,675	7.0	$ 195	-	$ -	-	$ -	$ -	$ -	$ -
Revise course content, syllabus	924	16.0	924		-		-	-	-	-	-	-
Revise manual, tutorials	601	8.0	462	5.0	139		-		-			-
Maintain Web site	344	5.0	289	2.0	56		-		-			-
	0						-		-	-		-
Develop Equipment & Software Needs	**$ 931**	6.0	$ 347	21.0	$ 585	-	$ -	-	$ -	$ -	$ -	$ -
Select New Instruments	86	1.0	58	1.0	28	-	-		-			-
Evaluate Computer Needs	139		-	5.0	139		-		-			-
Evaluate Software Needs	706	5.0	289	15.0	418		-		-			-
Purchase & Install new equip. & software	**$ 4,242**	0.0	-	36.0	$ 1,002	-	$ -	5.0	$ 139	$ -	$ -	$ 3,100
Purchase equipment & supplies	2,678	0.0	-	10.0	278		-		-		-	2,400
Purchase & update software	918		-	10.0	278		-	5.0	139			500
Additional server costs	200		-		-		-		-			200
Install new equip, soft. & train tech.	223		-	8.0	223		-		-			-
Test new equipment	223		-	8.0	223		-		-			-
			-		-		-		-			-
Train Personnel	**$ -**	0.0	$ -	0.0	$ -	-	$ -	-	$ -	$ -	$ -	$ -
Train faculty	0		-		-		-		-			-
			-		-		-		-			-
Teach the course	**$ 4,020**	45.8	$ 2,645	11.3	$ 313	50.0	$ 631	-	$ -	$ -	$ 1,250	$ -
Training of students	154	1.5	87	1.5	42	2.0	25		-			-
Oversee activity in lab	3,126	22.1	1,276	9.8	271	26.0	328		-		1,250	-
On line support for course		12.0				10.0						
Office hours	740	10.2	589		-	12.0	151		-			-
			-		-		-		-			-
Testing, grading, reporting	**$ 4,799**	70.0	$ 4,043	0.0	$ -	65.0	$ 820	-	$ -	$ -	$ -	$ -
Prelab Quiz and Exercises	578	10.0	578		-	5.0	63		-			-
Grading Prelab Quiz and Exercises	0	0.0	-		-		-		-			-
Grading laboratory reports	4,222	60.0	3,465		-	60.0	757		-			-
			-		-		-		-			-
	$ 15,862	150.8	$ 8,709	75.3	$ 2,095	115.0	$ 1,451	5.0	$ 139	$ -	$ 1,250	$ 3,100

A Reality Check

The savings realized in the case of the EE laboratory are real in the sense that by making the changes we can utilize the same laboratory for more courses, reducing the demand for new laboratory facilities. We could do this because the laboratory was already almost 100% utilized, and we needed more space for other laboratories that could use the same space and equipment. By making the changes in this course, we could accommodate another course in the same laboratory and therefore avoid building a new one.

This is an unusual situation, at least in our institution. Most teaching laboratories are not used 100% of the time. In fact the usage is much less than that. If we are to reduce costs, then we can only do it by sharing such laboratories across departments, i.e., by actually reducing total laboratory space and using it more efficiently. This is not as radical an idea as it seems, because these new laboratories could be better equipped, staffed by highly skilled technicians, and still cost less than they do now. In fact, one of the reasons why we could reduce the costs of the Electrical Engineering laboratory described above is because this laboratory is used for Electrical Engineering, Systems Engineering and Computer Science courses. Were it only used by the Electrical Engineering Department, no cost savings would be possible.

An Unexpected Bonus of this Effort

As the group of faculty and staff involved in this effort discussed the laboratory experiences in the four different departments, we discovered a great overlap in the experiments used by the different departments, i.e., the number of *distinct* experiments is limited and is far less than the total number of experiments performed in our undergraduate labs. For example, mechanical testing of materials is done in at least four different departments, using very similar techniques: in Civil Engineering, Mechanical Engineering, Bioengineering, and Materials Science. The only real differences are the gripping methods (tension vs. compression) and the materials themselves (concrete, steel, chicken bones or differently heat-treated Al alloys).

The faculty decided that it makes much more sense to concentrate these kinds of activities in one departmental laboratory under the supervision of one technician. As a result, students from all these departments are performing mechanical tests in the Materials Science laboratory, but as part of courses offered in the students' home department. The cost savings associated with this approach are obvious, but the approach also offers additional advantages.

Many times it is desirable to offer laboratory experiences as part of a regular, non-laboratory course. Normally, however, the activation barrier for doing this, in terms of obtaining test samples, preparing the equipment, and training the personnel is insurmountable, so it is not done. Now that we have many of these experiments on the web, and since there are personnel trained to do these experiments, we have the option of "Lab a la Carte," i.e., an instructor can go to the web, pick and choose from the experiments already being performed as parts of other classes (remembering that the number of *distinct* experiments we do is very limited) then schedule the experiments.

Persuading faculty to share laboratory space and experiments requires convincing them that they will realize a net gain for their students. These gains can be demonstrated only by providing faculty with better labs, better equipment, and better support with more highly skilled laboratory technicians.

Conclusions

The project team has shown that by using web-based teaching tools we can both improve the quality of an undergraduate laboratory while, at the same time, reduce costs. The team accomplished this by making a number of changes in the way laboratory courses are offered:

1. Now students prepare for laboratory periods by accessing more information on the web and beginning the laboratories online before class. Students can get a real feel for the experiments before coming to the laboratory, and furthermore, faculty can convey essential safety information (and give quizzes to see that they actually know the information) prior to the start of the laboratory period. This preparation has a significant impact on student productivity.
2. An institution-wide system of on-line grading greatly increases the efficiency and accuracy of the grade-reporting process. In the pre-lab quizzes, students receive immediate feedback, because of automatic grading.

3. Using special software on desktop computers to convert the computers into "virtual instruments" can dramatically reduce the costs of laboratory equipment. Since every laboratory station in most teaching laboratories now is equipped with a computer, there is no additional cost associated with the computers. Faculty adopted LabView as our standard, and purchased a site license for the School of Engineering and Applied Science.

4. Using the Flashlight (activity-based) approach to cost analysis, we have estimated the costs of teaching some of our laboratories. Improved student preparation allows us to decrease laboratory periods from three hours down to two hours, resulting in substantial savings in space and personnel costs (and opening up the laboratory for other classes for which the construction of an additional laboratory space would otherwise be required.). These cost savings, combined with the savings associated with the use of LabView software to replace hard-wired instruments, can exceed 30%. While these savings are not huge, they do constitute an important breakthrough because the costs of laboratory teaching have been increasing so rapidly for so long.

5. The increased utilization of some of our labs through this project reduces the pressure on the school to build new labs to accommodate growth in the demand for hands-on laboratory experimentation for students.

Acknowledgements

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CASE STUDY 3:

ROCHESTER INSTITUTE OF TECHNOLOGYCOST ANALYSIS RESULTS: COMPARING DISTANCE LEARNING AND ON-CAMPUS COURSES

Fall 1997-Fall 1998

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Rochester Institute of Technology

Final Report, March 1999

Abstract: *Costs of Rochester Institute of Technology's (RIT) site-based and anytime/anywhere (asynchronous) courses were compared to their on-campus counterparts in this preliminary study. Our main objective was to use the model to obtain a detailed, activity-based perspective on the operational costs of delivering distance learning courses. Results are being used as part of the RIT Distance Learning Strategic Plan.*

RIT was the second school to use the beta version of the activity-based cost analysis model developed at Indiana University Purdue University-Indianapolis (IUPUI) for the Teaching, Learning and Technology (TLT) Group Flashlight Program. RIT modified the model to fit its business objectives with activities categorized into six course components: faculty preparation, presentation, interaction, assessment, practice/application and evaluation. Within each component, tasks were identified and a survey instrument was developed to gather data about time on task, direct costs, and indirect costs for each activity.

Eight courses were selected from a possible 148, representing three colleges, undergraduate and graduate levels. Courses in the two primary formats of distance learning were identified as site-based and anytime/anywhere. Faculty members were selected for their experience in distance teaching in order to focus on the costs of delivery rather than up-front development. Faculty selected taught both the on-campus and distance learning versions of the courses in the quarter in which the survey was conducted.

Our findings reflected the wide variability in the activities involved in instruction. Faculty time was the largest and most variable portion of the total cost. The faculty members reports of teaching time per student varied by as much as a factor of three across the on-campus courses and by a factor of four across the distance learning courses.

One surprising finding was the perception of time by the faculty. Comparing different formats of the same course, all faculty felt they spent more time teaching the distance learning versions of their courses. The totals of the self-reported hours, however, indicated that only three of the nine distance learning sections consumed more time per student. Five sections consumed about the same amount of time per student and one section consumed fewer hours per student in the distance learning version.

The average cost of the anytime/anywhere courses and the site-based courses was roughly the same. The site-based courses had higher average costs supporting interaction and assessment. Anytime/Anywhere courses had higher average costs supporting preparation and practice. Comparing these costs to the average cost per credit hour of on-campus courses from the same college did provide some point of comparison. Results indicated eight of the nine course sections in our sample cost the same or less per credit hour as their on-campus counterparts.

Through this study, we gained a clearer understanding of our operating costs. We used the on-campus version of the course as a benchmark. Further study is needed to draw conclusions about the technology costs of the anytime/anywhere format, and the impact on faculty time of different technology choices.

INTRODUCTION

A 20-year veteran in distance education, RIT has offered distance learning courses in various formats since 1979 and introduced full-degree programs through distance learning in 1990 when it received a "New Pathways" grant from the Annenberg/CPB Foundation. Currently, RIT offers 20 of its degree and certificate programs in a variety of distance learning formats including synchronous and asynchronous forms.

RIT is in the first phase of a six-year initiative to triple distance learning enrollment from 3.7% to 10% of total credit hours generated by the university. The Distance Learning Task Force Report indicated that RIT can reach its goal of 10% of credit hours generated within six years, assuming four critical conditions are in place. Those are a focused and committed marketing effort; serious commitment from the colleges and faculty to produce and offer academic programs and courses of the highest quality; an institutionally supported faculty development effort; and a supporting infrastructure of staff, equipment, software and training.

The results of this cost analysis were intended to be used to address the following business objectives:

- Identify all costs associated with teaching a variety of distance learning courses. This information will help determine faculty compensation for teaching and developing distance-learning courses, as well as help determine staffing and other resources.
- Compare the costs of anytime/anywhere and site-based formats. Detailed costs can aid the transition of the college's current site-based degree program to a site-independent format.
- Determine costs associated with distance learning staff time and services in order to develop a "price sheet" for departmental charge backs.
- Determine costs associated with teaching on-campus versions of the selected courses. Provide detailed information for comparing on-campus and distance learning courses that go beyond the current Institute-wide averages.
- Identify revenue benefits of distance learning courses.

Determining the Sample Courses

Selecting courses for the study

Eight courses from a possible 148 were selected as the target group (Table 1). We kept the sample small because we were beta testing the model. Courses were well-established graduate and undergraduate courses where the faculty member would not be developing a new course for the format. Courses were selected from both the synchronous and asynchronous forms of existing distance learning courses. Courses selected also had on-campus versions taught in the same quarter by the same instructor. One course was taught in three different formats in the same quarter, making nine sections of eight courses in the sample.

Selecting faculty for the study

The selected faculty members were not new to the distance learning format. Our purpose was to compare the costs of delivering course work rather than the costs of up-front development time and faculty training. Another advantage of having experienced faculty participating in this project was that they could better delineate tasks and recall what it takes to be thorough and complete.

Faculty taught their courses in both a distance-learning and on-campus format during the quarter the study took place. The project team believed it was important to conduct the survey in the quarter that the courses selected were being taught so that the information would be as accurate as possible.

This was our first cost study and the data we were gathering was personal to faculty (i.e. how they spend their teaching time), therefore we selected faculty who had a record of being supportive of distance learning projects. The selected faculty members are considered among the best RIT faculty and are proponents of distance learning within their departments.

Selecting distance learning and support staff for the study

Staff consisted of a course developer, operations manager, project coordinators, faculty associates, and technical and clerical staff. This group interacted with faculty by coordinating schedules for recitations, phone conferences, and course materials. They also distributed materials, tests, quizzes and returned student work; helped to set up and administer online conferences; and designed evaluations for courses.

Other participants included media production staff members who developed and produced the various media used (video and audio tapes, web pages, print materials, etc.). Support personnel within each faculty member's department were also included in the study.

Table 3-1: Sample courses

College	Lower Division 100-200 level	Upper Division 300-500 level	Graduate Level	Major	Formats
Applied Science and Technology		X		Electrical Engineering Technology	Site On-Campus
Applied Science and Technology		X		Mechanical Engineering Technology	Site On-Campus
Applied Science and Technology	X			Environmental Management	Anytime/Anywhere On-Campus
Applied Science and Technology			X	Information Technology	Anytime/Anywhere On-Campus
Science	X			Mathematics	Site, KEY On-Campus
Science	X			Mathematics	RAITN On-Campus
Liberal Arts		X		Economics	KEY On-Campus
Liberal Arts		X		Political Science	Anytime/Anywhere On-Campus

Building the Model

We evaluated the costs of three types of instructional outputs in this study: courses taught using traditional means (on-campus courses); courses taught using technological means in an anytime/anywhere format; and courses taught using technological means in a site-based format. . For each type of output, we determined the activities and tasks that drive costs and developed activity grids (data worksheets). To determine the cost of each activity, we gathered data on direct and indirect costs including salaries, facilities, equipment, supplies, and services. We also surveyed faculty and staff to determine time spent on each task.

A. Outputs

On-campus – traditional classroom instruction.

Anytime/anywhere – asynchronous instruction using a range of technologies including FirstClass conferencing, telephone conferences, web resources, videotape, audio tape, and CD-ROM. Faculty use any combination of these technologies.

Site-based – RIT has three site-based programs:

1. *Electrical/Mechanical Engineering Technology Degree (E/MET)*- Students meet in groups at community colleges and corporate sites. Courses use the Optel Telewriter™ (audio and graphics) for live interaction; videotapes and print materials for presentation are used asynchronously. Faculty members visit the sites several times per quarter. Testing is done with proctors at the sites. Some faculty use e-mail to support interaction.
2. *KEY Program (K-12)* – A high school program that uses the Optel Telewriter (audio and graphics) for live interaction. Students also use videotapes and print materials for presentations in a class setting. Faculty visits the schools several times per semester and students come to RIT once per semester. Students meet in regularly scheduled, high school classes. Some asynchronous technology is used. Students take RIT courses for both high school and college credit.
3. *RAITN (K-12) – (Rochester Area Interactive Telecommunications Network)* – A high school program that uses live, two-way audio and video for class-to-class instruction to sites. FirstClass is used to distribute print materials and to support some asynchronous communication outside of class time. Students take RIT courses for both high school and college credit.

B. Activities and tasks

The IUPUI model identified eight major activities for administering a course or program:

- Concept/Projections
- Prepare Course Content
- Prepare Instructors
- Prepare Materials
- Market
- Enroll
- Instruct
- Evaluate

To meet our objectives, we narrowed our focus to the operational cost of instruction only and used six major activities as our primary course components. The six primary activity categories are:

- Preparation
- Presentation
- Interaction
- Assessment
- Practice/Application
- Evaluation

Within the primary activity categories, we identified approximately ten tasks. The tasks were the steps taken by faculty, Distance Learning staff, Educational Technology Center staff, and other support staff to teach a course. Here is one example:

Activity: Presentation

Tasks:

Develop details of course content

Plan Lectures

Identify & Gather Existing Materials (text, readings, media)

Determine Media Format

Schedule/Obtain Production Resources

Produce Own Materials

Produce Materials with ETC

Create Production Material

Caption/Transcribe

C. Costs

Costs associated with each task were identified and data sought for the activity grids through the university accounting office and distance learning records. Most costs associated with distance learning were available through Educational Technology Center and Distance Learning departmental records. Although tasks were identified for the classroom format, cost data were not available at the task level. Activity-based data was not available through our university accounting.

Anytime/anywhere task costs include:

- Media production (student time, staff time, facilities time, materials, captioning)
- Faculty compensation for up-front development (not included)
- Media duplication
- Media licensing
- Media distribution costs (scanning, file processing)
- Postage
- Transcription of non-captioned media and audioconferences
- Telephone charges for audioconferences
- Telecommunications line charges
- Student audio bridge operators
- Audio cassette supplies and postage
- Orientation mailings (how-to information for students)
- Mailing and faxing costs to exam proctors
- Marketing costs (not included)
- Advising (not included)
- Academic program development (not included)
- Service desk costs
- Technical support costs

Additional site format task costs include:

Telecommunications line charges at sites
Site visits
RIT and site conferencing equipment
Facility costs
Proctor fees
Site coordinator fees

Classroom format task costs include:

(With the exception of facility costs per square foot, costs for the identified tasks were not available at the detail needed for this study.)

Room (cost per square foot for facility)
Installed equipment
AV service
Media support
Library
Copying
Sign language interpreters and note takers

Faculty costs

In order to isolate delivery costs, we chose to normalize faculty costs so that our results would not reflect variability in salaries and the differences in adjunct and full-time compensation. We used RIT's average salary and benefits for full-time faculty to make the hourly cost the same in each course. Also included in faculty hourly cost was an estimated average for office cost per square foot, computer, furniture, supplies, telecommunications, and overhead.

Staff costs

Detailed information was used to populate the hourly cost worksheets for distance learning staff. Data included individual salary and benefits, office cost per square foot, furniture, supplies, equipment, telecommunications, and overhead.

Building costs

Data for the building cost worksheets for the classrooms, distance learning offices, and production facilities were obtained from university accounting and facilities.

D. Surveying time-on-task

The most complex part of the study was surveying faculty and staff to determine hours spent on each task. The survey matrix evolved from a written, essay-style survey form to a more complex and detailed interview grid. The team decided that with the small sample group, interviews rather than a stand-alone survey would be the most effective way to gather time information. Interviews would help ensure consistent interpretation of the tasks and allow interviewers to probe for complete information. The final interview matrix form, while complex, detailed

task steps and the things often taken for granted, which are significant steps in teaching a course. It should be noted that although many faculty and staff acknowledged the distinct tasks in the matrix, they often could only recollect blocks of time spent on groupings of tasks.

(Creating the survey) Involving faculty

In the developmental stages of the survey, the team worked closely with a faculty associate in Distance Learning Services and several faculty familiar with the department and the Flashlight Program. These faculty were involved in creating the matrix form, drafting the request for participation, and running through mock interviews with the working model. Faculty participation gave the team an important perspective on how the study and the survey would come across to the study group. It was critical in helping define the language used in the survey to ensure it was the language used by faculty to describe their course work and tasks. It was also key to getting "buy in" for this project.

Presenting the survey to faculty

The matrix evolved from a simple, one page essay-style presentation to the more complex and detailed interview matrix with cover letter produced by the team. The cover letter was an invitation to participate. It introduced the survey to faculty and noted their experience with the Distance Learning process. It spoke of their support of Distance Learning Services and the recent adoption of the growth plan outlined in the Distance Learning Task Force Initiative. It described the importance of faculty participation in our ongoing study to improve processes and procedures.

Conducting mock interviews with faculty

With the matrix in a final draft stage and the letter developed, a staff member and faculty member were asked to participate in mock interviews. This gave the team a chance to become more familiar with the material, hear how participants may respond and develop responses to what may be difficult or confusing topics or issues. It was at this point that the importance of defining terms became an issue the team had to solve.

Developing standard terms

It was important to define terms and time definitions to ensure consistency in the interviews. Documenting information and placing it in the correct sections of the matrix was also essential for consistent data collection. The team defined the six major activity categories and three time definitions as follows:

Activity categories

<u>Preparation</u> – the time needed to prepare for course delivery. It involved the assessment of a faculty's expertise using the format equipment and software; understanding Distance Learning processes and procedures; and general faculty preparation for delivery of an existing course.

<u>Presentation</u> – the preparation needed for the course materials. It included all elements of planning lectures, gathering materials, scheduling short-term production sessions (for updates to the original materials produced up-front) and distributing materials.

<u>Interaction</u> – the class time, after class discussions, chat sessions, office hours and travel to sites if appropriate.

<u>Assessment</u> – tests and quizzes.

<u>Practice/application</u> – special projects, papers and labs.

<u>Evaluation</u> – the process of developing, distributing and assessing course evaluations.

Time definitions

<u>Per quarter</u> –A one-time allotment of time spent per quarter on a specific activity or task.

<u>Per week</u> – This seemed to be the easiest breakdown for tasks because faculty and staff could recall the time per day or week they spent on a certain task.

<u>Per student</u> – This was asked in reference to evaluation of student work such as tests, quizzes and projects/papers. Faculty members were asked to determine time spent evaluating a quiz, for example, and time per student. This provided at least two ways to evaluate this time—it would be obvious that more time would be spent on a larger class of students.

Conducting faculty interviews

During interview sessions, the background of this project was discussed briefly. The faculty and staff interviewed were told more about the need for the information, how it would be used and a general time line for gathering and processing the information. One of the more important elements was confidentiality. Each faculty member was assured that information would be discussed with only the core group working on the matrix; all general information would be presented anonymously. No faculty would be referred to directly. Although the material would be made public, it was agreed that any notations would be general, such as "Information Technology course," rather than "John Doe's Telecommunications course."

Each member of our team was familiar with the participating faculty members and knew the elements of their courses. This background enabled us to uncover detailed information about the tasks and activities. There are many facets to delivering a course, yet to a faculty member, they are so common place that they are often taken for granted.

It was important also to have a personal touch to this survey. A face-to-face discussion about confidentiality seemed to increase cooperation and good will. In hindsight, this method also served as the best way to gather significant anecdotal information. This material was an added dimension of the survey and reinforced, for the first time, some of the impressions only heard in informal conversations with faculty and staff.

Tandem interviews were done for the first few sessions until the interviewing and reporting processes of the team became repeatable and routine. One member of the interview team would ask the questions while another wrote the answers. It was a way to have full concentration on what was being said and then to have a dual perspective on the information. It was also a back up situation in the case of intense, lengthy sessions. Several sessions went a half-hour; others took as long as two full hours.

Conducting staff interviews

Interviews were also conducted with staff in Distance Learning Services and in the academic departments. The team found that participants had difficulty separating time for individual faculty or individual course support. For example, when preparing for a new quarter, staff members contacted faculty through interoffice mail or e-mail as a group. Letters were all developed at once. Averages and percentages were used to tease out reasonable time estimates for individual courses.

Cost Analysis Findings

The sample provided us with information on a third of the KEY courses, one-sixth of the RAITN courses, and one-tenth of the other site-based courses. This gave us a good picture of the cost drivers of these site-based formats. However, the diversity in cost drivers in the anytime/anywhere format was not well represented by the three courses across three departments. Costs for courses in the on-campus format were unavailable at the detail required for the activity-based model. To get an approximation for comparison, we used the average cost per credit hour by college. Results indicated eight of the nine course sections in our sample cost roughly the same or less to deliver per credit hour as their on-campus counterparts (Table 3-2).

Table 3-2: Cost per credit hour
(To ensure confidentiality, dollar amounts are adjusted to a fictitious base value in order to show relative relationships while concealing confidential financial data.)

Course	Average College Cost Per Credit Hour	Site-Based Course Cost Per Credit Hour	Anytime/Anywhere Course Cost Per Credit Hour
Engineering Technology	$69	$64 (E/MET)	
Engineering Technology	69	54 (E/MET)	
Environmental Management	69		$69
Information Technology	69		30
Mathematics*	48 48	26 (E/MET) 16 (KEY)	
Mathematics	48	109 (RAITN)	
Economics	32	10 (KEY)	
Political Science	32		35

* Two distance learning sections of this course were included in the study.

Comparing anytime/anywhere and campus formats

Three courses in the sample group were offered both on-campus and in the anytime/anywhere format a political science course, an environmental management course and an information technology course. The three courses were from two different colleges. We compared the college's average cost per credit hour for the campus format, with the cost per credit hour calculated by the model for each of the three anytime/anywhere courses (Table 3-2).

Results showed that the political science and the environmental management courses had roughly the same cost per credit hour as their college averages (Table 3-2). In contrast, the information technology course was less than half (43%) of its college's average cost per credit hour. This course also generated significant net revenue from graduate tuition.

Other differences between the on-campus and anytime/anywhere formats of the same courses included differences in reported time by faculty in various course activities. For example, in the information technology course the faculty hours per student were roughly the same between the two formats (Table 3-5). The faculty member reported twice as many hours in preparation activities for the distance learning format. This increase, however, was balanced by fewer hours in presentation and interaction activities. In the environmental management course, the faculty member reported more than a 20% increase in hours per student in the distance learning version (Table 3-5). In this case, there were fewer hours reported for assessment activities but significantly more hours reported for interaction activities in the distance learning version.

The political science course is an example of a course going through an incremental update. The faculty member reported more than two and a half times as much time per student in the distance learning version than the on-campus version of the course (Table 3-5). The increased hours reflect updating activities such as learning a new software product for class discussions; more time in identifying and gathering existing materials to incorporate into the course; creating new presentation materials; and additional hours evaluating student's online participation. Reported hours in interaction, assessment, practice and evaluation activities were roughly the same in both formats.

The three anytime/anywhere courses in the sample represent less than 3% of the courses in this format. The diversity of cost drivers is not well represented by such a small sample. The anytime/anywhere courses in the sample cost roughly the same or less than the average cost per credit hour for their colleges (Table 3-2). They also took faculty the same or more hours per student to deliver (Table 3-5). More study is needed using a larger sample to draw more comprehensive conclusions about the anytime/anywhere format.

Comparing site-based and campus formats

Five courses (a total of six sections) in the sample were offered both on-campus and in a site-based distance learning format: two engineering technology courses, two mathematics courses, and one economics course. We compared the average college-specific cost per credit hour for the campus format with the cost per credit hour calculated by the model for each course. Results indicated that five of the six sections cost the same or less per credit hour in the distance learning site-based format (Table 3-2).

The two courses with the lowest costs per credit hour were a mathematics course and an economics course offered to high schools using the Optel Telewriter system (KEY program) (Table 3-2). One reason the costs to RIT were low is that the high school teachers oversaw most of the assessment and practice components of the courses. Technology costs were also low because the Telewriter data conferencing technology is older, low-cost, and used for many courses. On the revenue side, these courses broke even due to contract rates.

One section of a site-based math course used two-way audio and video over fiber (RAITN program) and had the highest total costs per credit hour due to high capital and telecommunications costs (Table 3-2). The course's total costs per credit hour were more than twice the costs per credit hour of its college average. The direct and indirect costs of the technology more than doubled the cost of the course. Contract rates were not sufficient to cover the costs.

Two site-based engineering technology courses (E/MET program) used the Optel Telewriter technology. Their average cost per credit hour was 15% less than the average cost per credit hour of on-campus courses in their college (Table 3-2). One section of a math course was also offered with this technology. It cost 46% less per credit hour than its college average (Table 3-2). These distance-learning courses had moderate total costs resulting from the costs for site coordinators and proctors and reported staff time to support site logistics. Two courses generated moderate net revenue from tuition. The other course generated high net revenue from a corporate contract that covered a significant portion of the costs.

The distance-learning versions of the two engineering technology courses averaged 27% fewer faculty hours per student than their on-campus counterparts as seen in Table 3-5. Most of this time was savings in presentation activities since this component used videotapes. Faculty also reported spending relatively fewer hours in interaction activities in the distance learning versions. The math course consumed 25% more hours per student of faculty time, despite significant reductions in presentation, primarily due to increased preparation and travel to sites (Table 3-5).

Comparing site-based and anytime/anywhere formats

None of the courses in the sample were taught in both a site-based and anytime/anywhere format. However, we can make some general comparisons. The average cost of the anytime/anywhere courses and the site-based courses was roughly the same (Table 3-3). The site-based courses had higher average costs supporting interaction and assessment activities. The anytime/anywhere courses had higher average costs supporting preparation and practice activities.

Table 3-3: Average cost by activity
(To ensure confidentiality, figures are adjusted to a base value that shows relative relationships.)

	Asynchronous Average Cost	Site-Based Average Cost
Preparation	214	68
Presentation	706	665
Interaction	621	847
Assessment	158	324
Practice	266	103
Evaluation	10	3
Total Costs	$1,975	$2,010

Looking at cost type also illustrates the difference between the two formats (Table 4). Costs for the anytime/anywhere format are primarily faculty time. Costs in the site-based format are primarily other costs such as site fees and technology costs. The biggest differences occur because the site-based courses had average "other" costs nearly two and half times those of the anytime/anywhere format. Courses in the anytime/anywhere format, on the other hand, had 66% higher average faculty costs than the site-based courses. Some of this increase in faculty time is due to the format and some of it reflects the different nature of the courses themselves.

Faculty time

Faculty time was the largest and most variable portion of the total cost. Faculty's reported time per student varied by more than a factor of three across the on-campus courses and by a factor of seven across the distance-learning courses (Table 3-5). In addition, the campus versions of the anytime/anywhere courses average 44% more reported faculty time per student than the campus versions of the site-based courses (Table 3-5).

One surprising finding was faculty's perception of time. Comparing different formats of the same course, the entire faculty felt they spent more time teaching the distance learning versions of their courses. The totals of the self-reported hours, however, indicated that only three of the nine distance learning sections consumed significantly more time per student (6-16 hours more per student).

Five sections consumed roughly the same as the on-campus versions (1-3 hours difference). One section consumed significantly fewer hours per student (10 hours less) in the distance-learning version (Table 3-5).

Table 3-4: Average cost by type
(To ensure confidentiality, figures are adjusted to a base value that shows relative relationships.)

	Anytime/Anywhere Course Costs	%	Site-Based Course Costs	%
Other Costs	450	23%	1107	55%
Faculty costs	1362	69%	822	41%
Staff Costs	163	8%	81	4%
Total Costs	$1,975	100%	$2,010	100%

Table 3-5: Reported faculty hours per student
(To ensure confidentiality, figures are adjusted to a base value that shows relative relationships.)

	On-Campus Course Hours Per Student	Site-Based Course Hours Per Student	Anytime/Anywhere Course Hours Per Student
Engineering Technology	27 hrs.	17 hrs. (E/MET)	
Engineering Technology	17	15 (E/MET)	
Environmental Management	27		33 hrs.
Information Technology	18		17
Mathematics*	8 8	10 (E/MET) 5 (KEY)	
Mathematics	8	36 (RAITN)	
Economics	7	5 (KEY)	
Political Science	8		20

In analyzing what faculty members were doing differently in their distance learning classes, the differing activities included developing weekly study guides for students as additions to the syllabus; for the more lab-based courses, adding more problem examples in written supplemental guides and more class demonstrations in videotaped lectures. One faculty member stated that she developed more tests, quizzes and writing assignments in distance learning settings. She believed she could better assess student understanding of material with the additional materials since she could not *see* students in a classroom where a confused look is more evident.

Some of the faculty also prepared additional materials for their distance learning classes, which enhanced the on-campus sessions as well. Others noted that that some of their time was spent presenting not only content material but also use of technology. Some of this additional course presentation was on electronic research techniques, along with training newcomers use equipment.

The wide variety in how faculty reported spending their time in the different course delivery activities raises more questions for further study. Larger samples in focused curriculum will enable inquiry into the nature of faculty and student interactions, perceptions of time, and potential efficiencies of the different formats.

Conclusion

The primary purpose of this preliminary study was to gain a better understanding of our operating costs. The findings have been very useful in identifying the major differences in activities and costs between the different formats of distance learning. However, further study is needed to draw conclusive comparisons between distance learning and on-campus formats. More work is required to obtain cost data at the activity level for on-campus courses. A larger sample is also required to better understand the anytime/anywhere format. In addition, future studies may want to consider another method of time study instead of using self-reported time for faculty and staff.

Results from this preliminary cost analysis have provided the following answers to the key business questions posed at the start of this study.

Identify all costs associated with teaching a variety of distance learning courses.

Through this study we have identified the various cost types and cost drivers in distance learning. We have gained a stronger understanding of our direct and indirect costs and we have a preliminary perspective on staff and faculty time.

Compare the costs of anytime/anywhere and site-based formats.

The anytime/anywhere format appears to have cost advantages over other formats primarily because it doesn't require sites and their associated staff and equipment costs. Further study with an expanded scope and a larger sample is needed for a better understanding of key cost drivers in this format including faculty time, costs to support interaction, and up-front development costs.

Determine costs associated with distance learning staff time and services in order to develop a "price sheet" for departmental charge backs.

Through this study we have identified the range of staff services we provide and have a glimpse into the time they consume. More comprehensive and accurate staff time reports are needed in order to develop a complete price sheet.

Determine costs associated with teaching on-campus versions of the selected courses.

Data for on-campus instruction beyond the Institute-wide averages were not readily available. We used average cost per credit hour by college as our cost comparison. We were not able to compare apples with apples.

Identify revenue benefits of distance learning courses.

Revenue and cost data suggest that graduate courses in the anytime/anywhere format offer the largest net revenue, followed by corporate contracts that exceed the high costs of site-based programs.

Faculty Observations about the Anytime/Anywhere Format

This preliminary survey was essential for gathering data about costs of delivery. It also served as a way to learn about other factors that influence a department supporting or not supporting distance courses. Here are some faculty comments that illustrate the advantages and disadvantages of the anytime/anywhere format.

Two faculty recalled on-campus students who had previously taken distance learning courses. They found that these students spoke up more in Distance Learning than they ever did in the classroom setting.

The survey also brought out discussion about expectations of timely responses and concerns about computer literacy. *"Students think that e-mail is instantaneous and that faculty respond as soon as they get the messages from students,"* said one faculty member. Student expectations of response times are higher in the distance formats than on-campus.

"This is communication of the future and people need to see it that way," said one faculty member. The same principles of communicating, presenting, and articulating are as necessary to the distance format as on-campus. This faculty perceived some of his students as taking advantage of the freedom of Distance Learning, but without the discipline needed to succeed.

In reference to distance learning courses as more time consuming to faculty, some faculty found that remedial work was required in other basic studies. One student told his professor when corrected because of his poor use of grammar and spelling errors, *"this is not a grammar class."* Three faculty members emphasized that they are getting sub-par work, even in the graduate classes, and must advise students about writing basics. Perhaps some of the time that faculty believe they are spending in the distance format is remedial work, or perhaps the format itself is such that it emphasizes writing skills or the students' lack of them.

Some faculty members found that the FirstClass conference was a good way to see the progression of student knowledge. Conference submissions by students were a good way to see not only how much they participate, but also *"the richness of their conversations"* (meaning the depth of their understanding of the materials), said one faculty member.

"Flexibility" and "control" were terms used repeatedly by faculty to describe success in the Distance Learning format. *"Faculty must give up control as an autocrat in front of class, students define structure for themselves,"* said one faculty member.

Finally, the survey brought out concerns about faculty promotion and compensation. Some faculty discussed the concepts of good teaching vs. faculty development: what constitutes development – increased content knowledge through research or development of new and improved teaching methods of delivery? Does the increase in technological expertise advance the faculty on the tenure track, or is it seen as less than valuable; are research of content

material and publishing the most important factors in promotion?

Recommendations for the Model

The IUPUI model is a strong and flexible foundation for developing individual school models. The ability for us to interact with the IUPUI model designers was important to the development of our individual application of the model. We recommend that there be some involvement with the IUPUI staff as consultants to develop common matrices, to define essential terms and concepts and to act as advisors for the costing data.

The basics of the model and the how-to sections are clear. They are simple enough to get the concept. For our purposes, we could have used three things:

Task development: we developed very detailed tasks following our instructional design model. However, faculty and staff reported back in numbers that grouped the tasks together. Having a common understanding of terms was critical for gathering accurate data and we spent a lot of testing out the terms we used. **Suggestion:** more detailed examples and suggested vocabulary.

Data collection: we chose to interview rather than use questionnaires because of the complexity of our tasks and to make sure the terms were clear. Through this process we also gathered valuable anecdotal information. **Suggestion:** example survey questions.

Time studies: we relied on self-reported time estimates for time on task that can lead to unreliable conclusions. **Suggestion:** information on more scientific time-study methods.

CASE STUDY 4:

GEORGE MASON UNIVERSITY
COMPARING COSTS OF DISTANCE AND CAMPUS-BASED COURSES: APPLYING NCHEMS AND NACUBO TECHNIQUES

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HigherEd.org

Abstract: *This study compares the net costs of online versus traditional delivery of pairs of courses in four disciplines at George Mason University in 1998-2000. The study diverges from the basic activity-based costing approach described in this Handbook in several respects. There is less interest in documenting the cost of specific tasks or activities, because data on faculty workload were not gathered at this level of specificity. Rather, there is a more direct application of the basic micro-costing techniques used in indirect cost recovery and supported in the literature of the National Center for Higher Education Management Systems (NCHEMS) and the National Association of College and University Business Officers (NACUBO).*

Relevant Literature

Modeling the costs of educational uses of technology is well served by understanding the general costing literature in higher education. The NCHEMS approach to cost of instruction models has been in place for almost thirty years. It is perhaps most useful today, when institutions have the tools to build online data marts and data warehouses that merge financial, student, facilities, and course datasets. Similarly, the literature of NACUBO for indirect cost recovery and micro- and macro-costing is invaluable. NACUBO literature includes Cost Accounting in Higher Education: Simplified Macro- and Micro-Costing Techniques (Jenny, 1996); A Cost Accounting Handbook for Colleges and Universities (Hyatt, 1983); and Meisinger's (1994) College and University Budgeting: An Introduction for Faculty and Academic Administrators.

Among the most important contributions of the cost literature are the concepts of: (1) enrollment data and departmental consumption/contribution; (2) space utilization and allocation costs; (3) revenue stream based on tuition and fees minus waivers and tuition discounting; (4) faculty workload; and (5) administrative overhead at the department, college/school, and institution-wide levels. This does not mean that only complex models should be built. But any model development ought to be done with a clear set of assumptions. If assumptions about revenue, for example, are to be ignored (perhaps because student tuition estimates and financial aid data are not available or are too complex to be analyzed within the timeframe and staffing level), this should be stated as a limitation of the model.

Methodology

A modified version of the Flashlight cost analysis methodology serves as the basis for this study.

For the purposes of the GMU Model, three new steps are inserted and one is modified. The step "identify the resources" is broken into two – for direct and indirect costs. The step for 'calculate costs for these activities' is also broken into two, with additional data about enrollment via the induced course load matrix. A new step is added to calculate revenue stream based on enrollment, tuition and fees, and financial aid data. "Document activities and tasks" is modified by not asking faculty to estimate how much time is spent on specific activities.

The revised steps of a cost model for analyzing online courses now include the following:

Define the resource issues

1. Choose outputs and performance measures
   Document activities and tasks
2. Gather faculty and staff workload data
3. Collect data on direct costs
4. Calculate data on hidden, indirect, or shared administrative costs
   Gather data on enrollment
5. Calculate results for each activity

6. Calculate revenue stream
7. Summarize the results

Steps for a Cost Analysis of Online Courses

1. Define the resource issues

This study compared the net costs of online versus traditional delivery of the same course and subject matter of four courses, one in each of four different disciplines, in 1998-2000. Table 4-1 documents the framework for comparison of online and traditional classes.

Table 4-1: Comparison of Online vs. Traditional Course Sections

Semester	Instructor	Type	Section
Fall 99	John	Online	ENGL300A
Fall 99	Jane	Classroom	ENGL300B
Fall 99	David	Online	MIS 200A
Fall 99	Sam	Classroom	MIS 200B
Spring 99	Mary	Online	DESC 200A
Spring 99	Louise	Classroom	DESC 200B
Spring 99	Iris	Online	ASTR100A
Spring 99	Peter	Classroom	ASTR100B

2. Choose outputs and performance measures

Two performance indicators were chosen to compare an online and traditional version of the same course: total net cost per course section and total net cost per course credit hour.

The number of course credit hours was determined by multiplying the number of students enrolled at the semester census date by the number of credits awarded for completion of the course. In order to estimate net costs, data had to be collected about student course-taking patterns, residency status, and tuition and fees charges in order to calculate revenue stream.

Table 4-2: Format for Analysis of Performance Measures

Semester	Type	Section	Net Cost per Section	Net Cost per Course Credit Hour
Fall 99	Online	ENGL300A	$	$
Fall 99	Classroom	ENGL300B	$	$
Fall 99	Online	MIS 200A	$	$
Fall 99	Classroom	MIS 200B	$	$
Spring 99	Online	DESC 200A	$	$
Spring 99	Classroom	DESC 200B	$	$
Spring 99	Online	ASTR100A	$	$
Spring 99	Classroom	ASTR100B	$	$

3. Document activities and tasks

The model developed in this paper did not involve gathering faculty estimates of the amount of time spent on different activities involved in teaching the various formats and subject matters. This feature was simply not practical without extensive faculty effort and record keeping.

Because online courses are developed over time, an amortization schedule was used to divide development costs across multiple offerings of the course. Each course amortization schedule is unique, based on the number of times the particular class would be offered and the degree to which the developed technology was likely to continue to change and require additional input/costs.

4. Gather faculty and staff workload data

Table 4-3 documents estimates by each faculty member about the percent of their time, which goes for instruction-related activities and the percent of this instructional time which is devoted to the specific course. For several of the faculty who are part-time, this will be 100% in each column, as they have no other assigned duties under the teaching contract. They may teach other classes, but these are usually covered under separate contracts.

Table 4-3: Faculty Workload for Instruction and Section

Semester	Instructor	Type	Section	Percent for Instruction	% of Instruction for Section
Fall 99	John	Online	ENGL300A	50%	30%
Fall 99	Jane	Classroom	ENGL300B	100%	100%
Fall 99	David	Online	MIS 200A	50%	50%
Fall 99	Same	Classroom	MIS 200B	100%	100%
Spring 99	Mary	Online	DESC 200A	50%	25%
Spring 99	Louise	Classroom	DESC 200B	40%	50%
Spring 99	Iris	Online	ASTR100A	65%	30%
Spring 99	Peter	Classroom	ASTR100B	50%	50%

5. Collect data on direct costs

Personnel Expenditures

Direct costs such as faculty compensation, including salary and benefits, are relatively easy to obtain from the institutional research, budget, and human resource office. However, it is important to verify these data with the faculty involved. This is especially true for part-time faculty who may teach several classes, each paid with a different funding record on different dates. Human resource data for these faculty will vary by date and funding record, depending on the extract date of the census file used for analysis.

Note: The term "extract file" or "census file" refers to a specific dataset that is "cut," "extracted," or created from the institution's administrative information systems. Human resource data would come from the human resources information system, student and course data from the student information system, and finance data from the financial information system. While there are many vendors for these systems, such as SCT Banner, PeopleSoft, Datatel, and Oracle, the fundamental natures of the systems are the same. When gathering data about people, students, courses, and money, institutional researchers must first obtain an extract of these data, usually by requesting the computing staff to run a special program to "cut" data on a certain date and put them in a certain format. These extract files are then used by institutional research, planning, budget, and assessment offices for many different kinds of studies.

Table 4-4 lists faculty compensation and benefits data for each of the comparison classes or sections.

Table 4-4: Direct Faculty Compensation & Benefits per Section

Section	Salary	Benefits Rate	Total Compensation	Comp. Per Semester	% for Instr.	Comp. for Instruction	% for Section	Comp. Per Section
ENGL300A	$61,435.00	23.50%	$75,872.23	$37,936.11	50.0%	$18,968.06	30.0%	$5,690.42
ENGL300B	$2,400.00	0.00%	$2,400.00	$2,400.00	100.0%	$2,400.00	100.0%	$2,400.00
MIS 200A	$102,962.00	23.5%	$127,158.07	$63,579.04	50.0%	$31,789.52	50.0%	$15,894.76
MIS 200B	$5,310.00	7.65%	$5,716.22	$5,716.22	100.0%	$5,716.22	100.0%	$5,716.22
DESC 200A	$84,084.00	23.50%	$103,843.74	$51,921.87	50.0%	$25,960.94	25.0%	$6,490.23
DESC 200B	$72,300.00	23.50%	$89,290.50	$44,645.25	40.0%	$17,858.10	50.0%	$8,929.05
ASTR 100A	$60,400.00	23.50%	$74,594.00	$37,297.00	65.0%	$24,243.05	30.0%	$7,272.92
ASTR 100B	$73,200.00	23.50%	$90,402.00	$45,201.00	50.0%	$22,600.50	50.0%	$11,300.25

Note: It is important to include other, non-faculty personnel who may be peripherally involved in offering the course. Examples include computing support staff who set up a special web server for the course or student wage employees who develop applications such as Java simulation exercises or ColdFusion™ templates administering online quizzes. Data on these costs were gathered with estimates from the faculty interviews conducted at the university being studied.

Table 4-5: Other Direct Personnel Costs for Online Sections

Section	Personnel	Time	Rate of Pay	Cost
ENGL300A	Course Instructor	Additional funding for course development	7K Amortized over 12 semester sections	$583.34
ENGL300A	MIS faculty	10 hours	60K + Benefits = $74,100 /2080 hours - $35.62 per hour/ Amortized as above	$29.69
ENGL300A	Research assistant	Spring 1999	$2,000 Amortized as above	$166.67
ENGL300A	Course consultant	Spring 1999	**$3,000 Amortized as above**	$250.00
ENGL300A	Course consultant	Spring 1999	**$2,000 Amortized as above**	$166.67
ENGL300A	Assessment developer	Spring 1999	**$2,000 Amortized as above**	$166.67
ENGL300A	Total		**Total**	**$1,976.05**
MIS 200A	Course Instructor	Additional funding for course development	$23,000 Amortized over 6 semesters	$3,833.33
MIS 200A	Eric	50 hours in semester	$13 per hour	$650.00
MIS 200A	Eric	20 hours per week in summer/10 weeks=200	$13 per hour. Amortized over 6 semesters	$433.00
MIS 200A	Jeff	10 hours	$13 per hour. Amortized	$22.00
MIS 200A	Jenny	10 hours	$13 per hour. Amortized	$22.00
MIS 200A	Eric's brother	One-time	$50 one-time	$50.00
MIS 200A	Total		**Total**	**$5,010.33**
DESC 200A	Course Instructor	Additional funding for course development	$8,000 Amortized over 6 semesters	$1,333.33
DESC 200A	TA for Spring 97	20 hours per week * 15 weeks = 300 hours	$10 per hour. Amortized	$500.00
DESC 200A	TA in Summer for Java	N/A	$3,000. Amortized	$500.00
DESC 200A	Total		Total	**$2,333.33**
ASTR 100A	Course Instructor	Additional funding for course development	$15,000 Amortized over 6 semesters	$2,500.00
ASTR 100A	Total		Total	**$2,500.00**

Non-Personnel, Direct Expenditures

A breakout of non-personnel expenditures is documented in the following table. These are amortized over time where appropriate. For two of the online courses, there are no expenditures of this type. The traditional course counterparts also have no such expenditures.

Table 4-6: Direct Non-Personnel, Non-Computing Costs for Online Sections

Section	Expenditure Type	Total Cost	Amortization	Section Cost
ENGL300A	Books	$200	Over 6 semesters	$33.33
ENGL300A	Conference Travel	$3,000	Over 6 semesters	$500.00
ENGL300A	Total		Total	$550.00
MIS 200A	Overheads	$10	N/A	$10.00
MIS 200A	Cassette Tapes	$1 per tape X 80; 20% lost per semester	$80 over 6 semesters; $20 extra per semester	$33.33
MIS 200A	Audio Duplication	$1 per tape X 80; 20% lost per semester	$80 over 6 semesters; $20 extra per semester	$33.33
MIS 200A	Total		Total	$76.66
DESC 200A	N/A	N/A	Total	$0.00
ASTR 100A	N/A	N/A	**Total**	$0.00

6. Calculate data on hidden, indirect, or shared administrative costs

Departmental Overhead

Data were obtained for each department and division in which course sections were offered: English (ENGL), Management Information Systems (MIS), Decision Sciences (DESC), and Astronomy (ASTR). For ENGL, there is a clear cost center in the department of English. Examining the account structure for MIS and DESC, the data show that only faculty salary and fringe benefits are pooled at the department level. It is therefore necessary to make calculations about these courses based on expenses and activity at the deans'/division level. ASTR is an interesting case, because the faculty member teaching the online course is in another smaller division that does not have separate department account structures. Cost analysis of the ASTR course must include a traditional version of the course, which in this case is offered in the department of Physics/Astronomy. This requires that departmental and division overhead charges be calculated for this comparison section.

Administrative overhead costs at the department level need to be calculated only for English and Physics/Astronomy. Division level overhead costs need to be calculated for the School of Management (SOM) where MIS and DESC are housed, the Institute for Computational Science and Informatics (ICSI) where the online astronomy faculty is located, and the College of Arts and Sciences (CAS) where the ENGL and Physics and Astronomy departments are housed. In each case, it is necessary to obtain financial expenditure data at the object code level within all instructional accounts related to each cost center. Also, since the ASTR and DESC sections were offered in spring 1999, overhead must be calculated for the 1998-99 academic year. The MIS and ENGL sections require overhead data for 1999-00.

In examining departmental overhead, it is necessary to delete expenses related to the other full-time and part-time faculty and graduate assistants who have no responsibilities for the courses in this model. The model should only prorate costs that may reasonably be associated with overhead for a course section. Only the overhead functions of administrators and classified/non-faculty staff should be included. Because fringe benefits costs are lumped together in one series of object codes at this university, it is necessary to calculate fringe costs separately. Per the Budget Director, these are estimated as 23.5% fringe for administrators and non-faculty staff and 7.65% for wage employees. There is no fringe benefit calculation for part-time, temporary, college work study, and student wage employees.

"Other than personnel" services (OTPS) expenditures are subtotaled separately. All types of instruction-related, non-personnel expenses such as copying and telephones that may not be directly tied to a specific course should be including in this estimate. If direct expenditures are included for the course and these were paid from the same account as the department or division account, then these should be subtracted from the total so as not to be counted twice.

After deleting faculty data and estimating fringe costs, the data on expenditures by object code appear in Table 4-7 for the English Department.

Table 4-7: Partial Expenditures by Object Code for English Department

Object Code	Description	Budget
1310	CLASSIFIED SALARY	109,838
	Fringe for classified	25,812
1400	BUDGET POOL-WAGES&OT	68,989
1420	WAGES-STUDENTS	6,111
1610	STUDENT WAGES CWS	5,000
2000	BUDGET POOL-OTPS	24,004
3110	EXPRESS SERVICES	186
3140	METERED MAIL	3,241
3144	BULK MAIL	20
3148	OTHER MAIL	271
3150	PRINTING SERVICES	14
3160	TELECOMM SVS DIT	29,100
3170	TELECOM SVS NONSTATE	7,245
3177	LONG DISTANCE TELE	2,063

These expenditures by object code are aggregated in sub-groups and totaled for each department. Table 4-8 shows the data for the Physics/Astronomy and English departments.

Table 4-8: Expenditures by Sub-Group by Department

Departmental Budget	1998-99 PHYS/ASTR	1999-00 ENGL
Classified Staff	54,418	105,200
Wages	8,296	0
Student Wages	7,446	6,111
College Work Study	7,500	5,000
Fringe - Classified/Admin Fac	12,788	24,722
Fringe - Wages	635	0
OTPS	55,983	121,136
Total Expenditures	147,066	262,169

As stated earlier, there are many ways to allocate overhead costs. A unique allocation scheme is necessary for the purposes of the online versus traditional course comparison. Usually, this calculation is done using student or course credit hours or major headcount. Credit hours are chosen for some models of departmental activity because headcount implies costs related to advising majors. Since decision-making, enrollment planning, content management, and staffing all take place at the level of the individual course section, this is the methodology chosen for this particular example

To allocate or prorate departmental expenditures per course section, it is necessary to know how many sections were offered during the academic year. This must include both fall and spring semesters. Summer enrollment, faculty contracts, and twelve-month administrative staffing in departments and deans' offices are unique issues not dealt with here, though they are important for analysis of online courses offered or developed during the summer months. Because all of the courses being studied were offered in either spring 1999 or fall 1999, the number of course sections is calculated accordingly.

The institutional research office of the university collects data on course section offerings for mandated state reporting and internal analyses. An existing series of enrollment reports capture these data at the division level, listing the number of sections by type offered by each division. Using the GMU Data Warehouse, these data were obtained for the four semesters of fall 1999, spring 1999, fall 1999, and Spring 2000 in order to estimate costs per section for the 1998-99 and 1999-2000 academic years. Special runs of the same report were required for the data at the department level. The data on departmental sections for English appear in Table 4-9.

Table 4-9: Total 1999-2000 Section Data for the English Department

English	Fall 1999	Spring 2000	Total
Lecture/Seminar Sections	265	270	535
Lab/Rct Sections	1	1	2
Total	266	271	537

These data were then used in conjunction with the expenditure data to calculate estimated departmental overhead costs per course section.

Table 4-10: Expenditures per Course Section for the English Department

Department Budget	ENGL 1999-00
Total Expenditures	$262,169
Total number of sections	537
Dept overhead per section	$488.00

Deans'/Division-Level Overhead

Only those accounts directly related to administrative operations should be included in this second set of calculations for dean/division-level overhead. These accounts were identified by using financial reports from the GMU Data Warehouse and verified by the GMU Budget Office. Again, only object codes for non-personnel (OTPS) expenditures, classified/non-faculty staff, and administrators are included. Other expenses for full-time and part-time faculty and graduate assistants were excluded because they do not contribute to the administrative overhead necessary to offer the courses. Data were combined by object code across accounts. Then fringe benefits were estimated using the same method described above for departments.

Table 4-11: Administrative Overhead Accounts within a Division

Account	Name
111274	IT&E LAB SUPPORT
111275	IT&E PT / GTA
111997	RESERVE DEAN IT&E
146010	DEAN IT&E
146011	IT&E CONTRACT COURSE SHARE
154075	IT&E GRAD ADMISSIONS

Table 4-12: Expenditures by Sub-Group by Division

Expenditure	ICSI	SOM	SOM	ITE	CAS	CAS
Division Budgets	1998-99	1998-99	1999-00	1998-99	1998-99	1999-00
Administrative Faculty	0	436,310	822,675	571,567	672,837	812,900
Classified Staff	197,161	670,434	771,647	187,171	399,099	410,386
Wages	0	11,438	17,144	61,531	25,022	19,102
Student Wages	0	41,552	20,409	69,269	4,995	8,092
College Work Study	7,500	15,000	12,000	6,000	3,600	3,000
Fringe - Classified/Admin Fac	46,333	260,085	374,666	178,303	251,905	287,472
Fringe – Wages	0	875	1,312	4,707	1,914	1,461
OTPS	124,798	410,895	836,714	389,199	249,630	389,046
Total Expenditures	375,792	1,846,589	2,856,566	1,467,748	1,609,002	1,931,460

Because services increase with increased student course load, the division and institutional overhead allocations are made by course credit hours, not by course sections. These data are obtained from the "Glimpse of Course Enrollment" reports that are produced each semester by the University's Office of Institutional Research and Reporting. Division data for one semester appears in Table 4-13.

Table 4-13: Fall 1999 Course Sections by Division

Academic Division	Course Level	Lec/Sem Sections	Lab/Rct Sections	Credit Hours	Total FTE
CAS	Undergrad	1,039	296	118584	7905.6
CAS	Graduate	220	15	10559	879.9
CAS	Total	1,259	311	129143	8785.5
ICSI	Graduate	25	0	659	54.9
ICSI	Total	25	0	659	54.9
ITE	Undergrad	93	88	12975	865
ITE	Graduate	106	0	7737	644.7
ITE	Total	199	88	20712	1509.8
SOM	Undergrad	153	2	25055	1670.3
SOM	Graduate	41	0	2572.5	214.4
SOM	Total	194	2	27627.5	1884.7

The data must be aggregated across semesters to obtain total course credit hours generated in the academic year, broken out by division. With these results, division overhead costs per section and per course credit hour were then be calculated as in Table 4-14.

Table 4-14: Overhead Cost Calculations by Division

	1998-99 ICSI	1998-99 SOM	1999-00 SOM	1998-99 ITE	1998-99 CAS	1999-00 CAS
Total Expenditures	375,792	1,846,589	2,856,566	1,467,748	1,609,002	1,931,460
Total Sections	45	409	419	570	2,991	3,124
Division Overhead per Section	8,351	4,515	6,818	2,575	538	618
Course Credit Hours (Academic Year)	1,091	54,938	56,329	40,108	242,144	248,685
Division Overhead per Course Credit Hour	$344.45	$33.61	$50.71	$36.59	$6.64	$7.77

There is wide variation in overhead costs per course credit hour. The ICSI division, which produces far fewer sections, is much more expensive. Notice that deans'/division-level overhead is an important cost driver.

Table 4-15 uses the calculated cost per course credit hour by division and applies it to the four pairs of comparison sections.

Table 4-15: Division Overhead Costs per Online Section

Overhead Calculations	Online	Classroom	Online	Classroom	Online	Classroom	Online	Classroom
Class Section	ENGL300A	ENGL300B	MIS200A	MIS200B	DESC200A	DESC200B	ASTR100A	ASTR100B
Headcount Enrollment	13	22	76	81	85	62	48	306
Course Credit Hours	39	66	228	243	255	186	144	918
Division overhead per course credit hour	7.77	7.77	50.71	50.71	33.61	33.61	344.45	6.64
Division overhead for online section	302.90	512.60	11,562.38	12,323.06	8,571.12	6,251.88	49,600.39	6,099.94

Institutional Overhead

To calculate overhead at the institution level, it was first necessary to separate academic divisions that generate courses from those purely administrative or operational units such as student affairs, computing, and libraries. Using the GMU Data Warehouse, financial data on budgets for expenditures were obtained for the two years during which course sections met, 1998-99 and 1999-00. The list of divisions and expenditures appears in Table 4-16. After the data on budget by division are totaled and the course credit hours offered over the two semesters of each academic year totaled, the cost per course credit hour was calculated.

Table 4-16: Institutional Overhead Budgets by Division

Division	1998-99 Budget	1999-00 Budget
Balance Appropriation	3,982,301.00	4,328,178.00
Multi-Campus	783,712.00	773,026.00
Budget & Planning	1,008,812.00	1,019,749.00
Campus Life	543,068.00	681,530.00
Instr. Improvement & Technology	2,910,801.00	3,277,183.00
Enrollment Services	3,640,611.00	3,807,455.00
Senior Vice President	1,469,411.00	1,188,887.00
Fiscal Services	3,239,573.00	3,412,583.00
Human Resources	1,553,217.00	1,658,936.00
Instructional Support	2,581,769.00	2,479,951.00
Information Technology & Support	382,133.00	1,597,316.00
Library	8,992,581.00	9,612,538.00
Operations	2,648,634.00	3,278,338.00
Plant/Facilities	12,878,921.00	13,707,845.00
Executive Affairs	1,559,141.00	1,708,639.00
Academic Administration	4,088,030.00	4,636,672.00
Property Rental	1,095,000.00	2,080,000.00
Student Development	2,048,111.00	2,343,562.00
Safety Operations		566,382.00
University Life	1,239,911.00	1,323,725.00
University Development	1,108,453.00	1,221,669.00
University Computing & Info Systems	9,857,663.00	11,197,084.00
University Relations	2,632,316.00	2,642,767.00

Using the total budget per year in institutional overhead made it possible to calculate the cost per course credit hour. For this performance measure, the number of course credit hours in all divisions was totaled for both semesters in each academic year. The results appear in Table 4-17.

Table 4-17: Institutional Overhead Calculations per Course Credit Hour

Division	1998-99 Budget	1999-00 Budget
Total expenditures	$70,300,697.00	$78,601,221.00
Academic Year Course Credit Hours	444,779.00	451,152.00
Cost per course credit hour	$158.06	$174.22

After the cost per course credit hour was calculated, those figures were used to obtain the institutional overhead costs for each section as seen in Table 4-18.

Table 4-18: Institutional Overhead Costs per Section

Overhead Calculations	Online	Classroom	Online	Classroom	Online	Classroom	Online	Classroom
Class Section	ENGL300A	ENGL300B	MIS200A	MIS200B	DESC200A	DESC200B	ASTR100A	ASTR100B
Headcount Enrollment	13	22	76	81	85	62	48	306
Course Credit Hours	39	66	228	243	255	186	144	918
Institutional overhead per course credit hr	174.22	174.22	174.22	174.22	158.06	158.06	158.06	158.06
Institutional overhead	6,794.71	11,498.74	39,722.93	42,336.28	40,304.69	29,398.71	22,760.29	145,096.87

Space Costs

The first step for this part of the model was to obtain an "extract file" from the University that contained course meeting data for the semester in which the section met. Using data on the stop and start dates for which the class was offered, the days of the week the class met, and the beginning and end meeting times, it was possible to calculate the amount of time each class met per day, week, and semester. This total time per class per semester was then calculated as a percentage of the total time in which a room was utilized for instruction to prorate space costs. A portion of a course meeting file for the university is displayed in Table 4-19.

Table 4-19: Course Meeting File for Classroom Utilization Statistics

Term	Disc	CNUM	Sect	Start	Stop	Days	BLDG	Room	Begin	End	Class Time	Weekly Time	Total Time
99F	PHYS	122	1	8/30/39	9/29/39	T R	ENT	275	9:00	10:15	1:15	2:30	10:42
99F	PHYS	123	1	10/4/39	11/3/39	T R	ENT	275	9:00	10:15	1:15	2:30	10:42
99F	LRNG	602	1	9/9/39	10/14/39	F	ENT	275	18:00	21:30	3:30	3:30	17:30
99F	LRNG	602	1	9/17/39	10/22/39	S	ENT	275	9:00	16:30	7:30	7:30	37:30
99F	PUAD	660	2	8/26/39	10/7/39	F	ARL	257	18:00	21:00	3:00	3:00	18:00
99F	PUAD	661	1	10/21/39	12/9/39	F	ARL	257	18:00	21:00	3:00	3:00	21:00
99F	PUAD	660	2	8/20/39	10/8/39	S	ARL	257	9:15	17:15	8:00	8:00	56:00
99F	PUAD	661	1	10/15/39	12/10/39	S	ARL	257	9:15	17:15	8:00	8:00	64:00

For the purposes of this study, the local commercial, space rental rate of $25 per square foot per year was used, prorated over the course of three semesters to $8.33 per square foot per semester.

Table 4-20: Space Costs per Course Section

Section	Room	Sq Feet	Cost per SF for semester	Total cost	Hrs used	Total use	%Use	Space cost
ENGL300A	Online	0	8.33	$0.00	0:00	0:00	0.0%	$0.00
ENGL300B	Robinson B222	484	8.33	$4,031.72	40:00	981:20	4.1%	$164.34
MIS 200A	Online/FAB B108	1,050	8.33	$8,746.50	6:00	502:40	1.2%	$104.40
MIS 200B	AQ 102	1,392	8.33	$11,595.36	40:00	613:20	6.5%	$756.22
DESC 200A	Online/AQ 102	1,392	8.33	$11,595.36	12:00	632:25	1.9%	$220.02
DESC 200B	ST 131	1,794	8.33	$14,944.02	43:25	732:51	5.9%	$885.34
ASTR 100A	Online	0	8.33	$0.00	6:00	0:00	0.0%	$0.00
ASTR 100B	LH 1	2,556	8.33	$21,291.48	40:42	374:34	10.9%	$2,313.51

Note that two of the online courses, ENGL300A and ASTR100A, did not meet at all on campus. The other two online courses met two and four times respectively on campus, usually at the beginning and end of the semester, for orientation and for exams.

In addition to these classroom costs, it was important to estimate the amount of other space used by the faculty and course. In conducting interviews or surveys with faculty about the course, information was collected about other space they used. Where it was difficult to obtain these data, the same estimates used for percent of instruction devoted to instruction and to the individual course section were also applied to percent of use for faculty office space. Table 4-21 illustrates the calculation of this non-classroom space.

Table 4-21: Non-Classroom Space Costs per Course Section

Section	Room	Type	% Use	Space Amt	Calculation	Cost
ENGL300A	Rob A421	Office	5.0%	107 SF	5% X (121 SF X $8.33 per SF)	$50.40
ENGL300B	Part-time	None	n/a	n/a	n/a	n/a
MIS 200A	ENT 146	Office	30.0%	121 SF	30% X (121 SF X $8.33 per SF)	$302.38
MIS 200A	ICASIT Center	Office	n/a	1 of 3 rooms	1 room in Center (1/3 X 1200) = $400 per mo X 10%	$40.00
MIS 200A	Total				Total	$342.38
MIS200B	Part-time	None	n/a	n/a	n/a	n/a
DESC200A	ENT 152	Office	20.0%	128 SF	20% X (121 SF X $8.33 per SF)	$213.25
DESC200B	ENT 144	Office	20.0%	140 SF	20% X (121 SF X $8.33 per SF)	$233.24
ASTR100A	ST1 109	Office	20.0%	118 SF	20% X (121 SF X $8.33 per SF)	$196.59
ASTR100B	ST1 213	Office	20.0%	141 SF	20% X (121 SF X $8.33 per SF)	$234.91

Computing Support Costs

Direct computing costs included in the model were the computer, printers, and network used by the faculty, staff, graduate assistant, and (sometimes) the students in the course. Some estimates were made from data about faculty workload, paralleling the calculation of faculty office space usage. For example, if 65% of a faculty member's activities was instruction-related, then 65% of the personal computer cost was assumed to be instruction related. Suppose this faculty member taught four courses per academic year. It seemed reasonable to assume that 16.25% (1/4 of 65%) of the amortized semester's cost for purchasing the PC and 16.25% of direct software and other computing costs could be allocated to each of the four course sections.

Another method for estimating direct computing costs is to interview each person involved in the course about the equipment and software and the percent of time used for the specific section. This second method was adopted for the comparison of online courses in this paper as seen in Table 4-22.

Table 4-22: Direct Computing Costs per Section

Section	Type	Total Cost	Amortization	Cost per Section
ENGL300A	Cable modem	$50 per mo	None. 50% for class	100.00
ENGL300A	Telephone line	$20 per mo	None. 50% for class	40.00
ENGL300A	Computer	2,500.00	Six semesters, 25% for class	104.17
ENGL300A	Scanning software	100.00	Six semesters, 25% for class	4.17
ENGL300A	Total		Total	248.33
ENGL300B	None	0.00	None	0.00
MIS 200A	Internet Service	$50 per mo	None. 5% for class	10.00
IS 200A	Compaq Computer	1,500.00	Six semesters, 25% for class	62.50
MIS 200A	Home Computer	2,400.00	Six semesters, 25% for class	100.00
MIS 200A	Total		Total	172.50
MIS200B	None	0.00	None	0.00
DESC200A	Computer	2,000.00	Six semesters, 50% for class	83.33
DESC200B	Computer	2,000.00	Six semesters, 50% for class	83.33
ASTR100A	Computer	2,000.00	Six semesters, 50% for class	83.33
ASTR100B	Computer	2,000.00	Six semesters, 50% for class	83.33

Data on indirect computing costs such as Internet access and threaded discussion groups are also needed for the course sections. These data are very hard to collect and the allocation schemes necessary for prorating usage across courses or transactions are rudimentary at best. For the purposes of the model described in this paper, these indirect computing costs will be assumed to be included in the institutional overhead calculation for computing which is allocated per course credit hour.

7. Gather data on enrollment

Table 4-23 of information about headcount and course credit hour enrollment was needed in order to calculate the two performance measures.

Table 4-23: Enrollment per Section

Section	Headcount	Course Credit Hours
ENGL300A	13	39
ENGL300B	22	66
MIS200A	76	228
MIS200B	81	243
DESC200A	85	255
DESC200B	62	186
ASTR100A	48	144
ASTR100B	306	918

8. Calculate results for each activity

Table 4-24 lists each type of cost calculated in the model and provides the total expenditures per course section.

Table 4-24: Total Expenditures per Section

Expenditure	ENGL300A	ENGL300B	MIS200A	MIS200B	DESC200A	DESC200B	ASTR100A	ASTR100B
Direct faculty salaries & benefits	5,690.42	2,400.00	15,894.76	5,716.22	6,490.23	8,929.05	7,272.92	11,300.25
Other personnel costs	1,976.05	0.00	5,010.33	0.00	2,333.33	0.00	2,500.00	0.00
Direct, non-personnel costs	450.00	0.00	76.66	0.00	0.00	0.00	0.00	0.00
Departmental overhead	488.00	488.00	n/a	n/a	n/a	n/a	n/a	1,149.00
Division overhead	302.90	512.60	11,562.38	12,323.06	8,571.12	6,251.88	49,600.39	6,099.94
Institutional overhead	6,794.71	11,498.74	39,722.93	42,336.28	40,304.69	29,398.71	22,760.29	145,096.87
Classroom space costs	0.00	164.34	104.40	756.22	220.02	885.34	0.00	2,313.51
Office space costs	50.40	0.00	342.38	0.00	213.25	233.24	196.59	234.91
Direct computing costs	248.33	0.00	172.50	0.00	83.33	83.33	83.33	83.33
Total Expenditures	**16,000.81**	**15,063.68**	**72,886.33**	**61,131.78**	**58,215.96**	**45,781.55**	**82,413.52**	**166,277.81**

9. Calculate revenue stream Tuition Revenue-based on Enrollment

Table 4-25 shows a portion of an extract file is displayed to illustrate the calculation of tuition revenue based on credit hour load and residency status. This requires knowledge of the institution's tuition policy, particularly for out-of-state students who take the maximum number of hours permitted without paying additional tuition charges per credit.

Table 4-25: Section Enrollment by Residency, Hours Taken for Revenue Stream

TERM	Section	Level	Residency	Total Hrs Taken	Total Tuition Charges	Percent of Hours for Section	Class Tuition
99B	ASTR100	FR	In-State	3	$454.50	100.00%	454.50
99B	ASTR100	FR	In-State	12	$2,172.00	25.00%	543.00
99B	ASTR100	FR	In-State	12	$2,172.00	25.00%	543.00
99B	ASTR100	FR	In-State	12	$2,172.00	25.00%	543.00
99B	ASTR100	FR	In-State	13	$2,172.00	23.08%	501.23
99B	ASTR100	FR	In-State	18	$2,353.00	16.67%	392.17
99B	ASTR100	FR	In-State	11	$1,991.00	27.27%	543.00
99B	ASTR100	FR	Out-of-State	11	$5,731.00	27.27%	1563.00
99B	ASTR100	FR	Out-of-State	12	$6,252.00	25.00%	1563.00

Financial Aid

In calculating the amount of revenue generated by an online course's enrollment, the results need to be adjusted based on financial aid. Just as the institution's course file is used to document the total number of classes taken by students in the course, financial aid extracts are used for this part of the model (if available). However, these data files are complex and easy to misinterpret.

Financial aid data are used to offset the expected tuition and fees charge. This is the net of the tuition and fees charges after any internal tuition discounting or waiver that may be in place. For most purposes, it is adequate to estimate the percent of enrollment by course level with waivers and with tuition discounts. The average tuition discount per student level or course level may be calculated by the financial aid office, perhaps as part of routine reports for admissions guides or the institutional fact book. These discounts are often labeled as institutional scholarships or grants.

Revenue Stream Calculations

From these raw course and tuition and fees data by student, it is possible to aggregate or group to the course section and calculate the total revenue stream.

Table 4-26: Estimated Revenue Stream per Course Section

Section	In-State Tuition	Out-of-State Tuition	Total Class Tuition	In-State Enrolled	Out of State Enrolled	% In-State	Total Enrolled
ENGL300A	$5,593.31	$0.00	$5,593.31	13	0	100.0%	13
ENGL300B	$7,554.82	$4,298.25	$11,853.07	19	3	86.4%	22
MIS 200A	$28,030.32	$9,321.39	$37,351.71	69	7	90.8%	76
MIS 200B	$31,374.79	$5,205.13	$36,579.92	77	4	95.1%	81
DESC200A	$33,740.87	$14,947.61	$48,688.48	73	12	85.9%	85
DESC200B	$24,521.05	$15,445.97	$39,967.02	50	12	80.6%	62
ASTR 100A	$21,677.23	$2,571.60	$24,248.83	46	2	95.8%	48
ASTR 100B	$127,597.84	$45,706.41	$173,304.25	272	35	88.6%	307

Table 4-27: Adjusted Revenue Stream based on Institutional Aid

Section	Total Class Tuition	Total Enrolled	Full-time	Institutional. Aid (2%)	Amount of Aid (3,561 avg)	Adjusted Class Tuition
ENGL300A	$5,593.31	13	21	0	0	$5,593.31
ENGL300B	$11,853.07	22	8	0	0	$11,853.07
MIS 200A	$37,351.71	76	74	1	3,561	$33,790.71
MIS 200B	$36,579.92	81	72	1	3,561	$33,018.92
DESC200A	$48,688.48	85	80	2	7,122	$41,566.48
DESC200B	$39,967.02	62	55	1	3,561	$36,406.02
ASTR 100A	$24,248.83	48	37	1	3,561	$20,687.83
ASTR 100B	$173,304.25	307	285	6	21,366	$151,938.25

To calculate the effect of institutional aid, student enrollment data are analyzed based on the number of credit hours taken to document whether students are categorized as full- or part-time (for purposes of determining their eligibility for financial aid). The number of full-time students is totaled for each course section. Data reported by institutions to the NCES for 1998-99 financial aid awards was used to get the percent of students receiving institutional aid

Two more cost drivers for the model are the percent of students receiving institutional grants and scholarships and the average award amount at this institution (2%) and the average amount of aid they received ($3,561). This figure was applied to the full-time student number to estimate the number of students who would probably have received institutional aid. This financial aid per section is subtracted from the total tuition estimate obtained above to get an adjusted revenue stream. Table 4-27 documents these calculations.

Differential Tuition Rates and Revenue Streams

There has been some timely discussion about differential tuition rates for online and site-based classes. Why should online students help pay for services they do not use? Also, if online courses are often more expensive than site-based classes to develop, should not this cost be passed on to students?

This issue is muddied because the few studies that have been done about online versus site-based courses suggest that it is traditional age campus students who often take online classes to supplement regular classes. Some institutions claim that they do not want to attract outside, part-time students with their online courses, but simply to serve their existing students in different and more efficient and effective ways.

For this reason, a true discussion of adjusted revenue stream and the net cost of online courses must somehow account for the difference in expenditures serving students who take only online courses versus those who use campus services. The indirect cost approach used in this GMU model effectively passes on the cost of libraries and student services and technology to all students based upon student credit hour consumption. Yet online students do not use these services. They do, however, use other services more intensely, such as online registration and all of the support costs of online technology. Note that direct costs of the online technology, if known, are included in the class cost; but only if there is an appropriate way to amortize, pro-rate, and allocate these costs across some useful measure of consumption. An example would be the number of postings per class to a threaded discussion group, divided somehow by the number of postings and threads for all classes using the software during a period of time.

To account for these differences, users must be informed about the separate technology costs for every unit serving online students. While these studies have been done and there is much interest in understanding the full cost of online courses, this is outside of the purpose of this chapter, which is

Table 4-28: Performance Measure Results per Course Section

	Online ENGL300A	Classroom ENGL300B	Online MIS200A	Classroom MIS200B	Online DESC200A	Classroom DESC200B	Online ASTR100A	Classroom ASTR100B
Total Expenditures	$16,000.81	$15,063.68	$72,886.33	$61,131.78	$58,215.96	$45,781.55	$82,413.52	$166,277.81
Total Revenues	5,593.31	11,853.07	33,790.71	33,018.92	41,566.48	36,406.02	20,687.83	151,938.25
Net Cost per Section	10,407.50	3,210.61	39,095.62	28,112.86	16,649.48	9,375.53	61,725.69	14,339.56
Course Credit Hours	39	66	228	243	255	186	144	918
Cost per Course Credit Hour	410.28	228.24	319.68	251.57	228.30	246.14	572.32	181.13
Net Cost per Course Credit Hour	$266.86	$48.65	$171.47	$115.69	$65.29	$50.41	$428.65	$15.62

reporting on the GMU implementation of a modified Flashlight cost model. A true activity based costing approach of non-academic units should be done in this area. Indiana University's Responsibility-Centered Management (RCM) approach is an excellent example of how to break apart the usual focus on cost centers to look at the cost of an activity across different administrative and academic units.

10. Summarize the results

This final step brings the expenditure and revenue components of the model together to calculate the overall cost of course sections using the performance measures. Table 4-28 depicts the performance measure results of the completed study.

Discussion

The results suggest, first of all, that it is possible to develop this type of complex model with data available within the existing administrative information systems of most universities.

Second, in terms of total expenditures, all of the pairs of sections are relatively in the same range except ASTR, which has high overhead per course credit hour but also high revenue.

Net costs per section are noticeably higher for online courses. The ratio is 3:1 for ENGL and 4:1 for ASTR. Total net costs per section vary widely based on the institutional overhead cost, which increases with course credit hours. Net costs per course credit hour, which evenly distributes institutional overhead, vary widely, from $15.62 for a traditional section of astronomy to $428.65 for the online section of the same course. The MIS and DESC net costs are somewhat similar between the traditional and online sections, but the online version of the English course is five times the traditional. Why is there so much variation?

- There is a benefit to offering online courses in departments and divisions that already generate extensive course sections. It is the allocation of division overhead charges that make the online astronomy section expensive to offer. If the same section were offered within the department of Physics and Astronomy, housed in the College of Arts and Sciences, the costs would be much lower, even with the same faculty compensation expenditures. Perhaps it should have been costed within this department, but it was the more expensive division where it originated.
- There are significant startup costs in personnel. Even though amortized over the course of six to twelve course offerings, the online course will bear this additional expenditure. Hopefully, content development is not an ongoing process. At some point in time, online content may begin to pay for itself. This would show up in the model as decreased faculty workload in teaching the section and decreased need for additional personnel costs.
- Full-time faculty, most of them tenured and at least one at the full professor level, teaches all of the online courses. This ensures the quality of the online offering, but increases costs. The traditional sections of ENGL and MIS are much more expensive if full-time faculty are used instead of part-time. This brings up the necessity of comparing apples to apples and oranges to oranges. Only the DESC pair of sections includes the same use of full-time faculty and the same overhead structure. ENGL and MIS have different types of faculty in the comparison sections. ASTR crosses divisions and departments in overhead. In hindsight, costs should be modeled only for course sections that

share the same attributes and differ only in their use of the Internet for delivery.

- Space is a factor in cost-savings that is realized with the online courses, though less so when these sections still meet occasionally on campus. This factor, too, varies by course. The section with the highest space costs, ASTR100B, met in a room that had fewer classes meeting in it. This higher utilization rate translated into higher costs. Calculation of utilization rates, though time consuming and difficult to do, is possible with existing course meeting files obtainable from the registrar's or institutional research office. Winston's concept of opportunity cost is a reasonable method for estimating the true cost of classrooms and takes into account depreciation and maintenance (Kirshstein et al, 1997; Winston, 2000)

Tweaks of the Cost Drivers

If one were to use a model of this type to estimate whether online and traditional courses have fundamentally different costs, it would be essential to select pairs of online and traditional sections that have the same faculty compensation rate; faculty workload; departmental, division, and institutional overhead; headcount enrollment and course credit hours; and use of office space. Then the only difference would be in the use of other personnel and direct OTPS costs to develop the online course, the use of classroom space, and increased use of computing equipment and software.

While the traditional section has additional space costs, it does not have the development costs. Over time, as development costs for the online course decrease, it becomes proportionally less expensive than the traditional section.

A similar scenario could be created in order to estimate the effects of increased enrollment on costs. With everything else being equal, the online section would generate more revenue without additional space demands; in contrast, the traditional class is bound to available classroom scheduling and faculty workload constraints. Given that so many factors may not be equal in a particular costing model, planners need to construct worksheets that will allow them to tweak different cost drivers and build these types of scenarios.

Perhaps the most valuable use of models lies in forcing planners and institutional researchers to document and question assumptions. Some of the most important by-products of this process are information about the changing nature of faculty roles in online teaching and a better understanding of cost drivers and how these may be used to ensure cost-effective uses of technology.

Clearly, one of the greatest hurdles for planners is in gathering the data they need about faculty workload, administrative cost sharing, and other hidden or indirect costs such as computing support. For the purposes of the study described in this paper, it was impossible to collect activity-based costing data within the constraints of the project timeline and scope. Adequate assumptions about faculty workload for instruction and for the individual course section may be made, but the argument for better data is compelling.

What is most critical to helping institutions prepare for cyber-colleges and web-based courses is a vision of what is possible with resource planning models of this type. By following the steps of the Flashlight Handbook, planners are better able to address the competing tensions and priorities of complex academic issues. Planners and institutional researchers alike do their institutions and themselves a disservice if they neglect to use the tools and data at hand to help make decisions about the future of online learning.

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CASE STUDY 5:

THE 'LEARNING TO TEACH WITH TECHNOLOGY' STUDIO MAINSTREAMING COST ANALYSIS INTO THE DEVELOPMENT AND EVALUATION OF DISTANCE EDUCATION PRODUCTS

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Abstract: *This chapter examines issues with mainstreaming cost analysis into the development and evaluation of a distance education product. The Learning to Teach with Technology Studio*[2] *(LTTS) is an online professional development system designed to help teachers learn to integrate technology to support inquiry and problem solving. A three-year case study of the project's cost model is presented along with barriers related to mainstreaming the cost model system into the project's development and evaluation cycles. Issues related to understanding the cost model system as an ever-evolving process are also addressed.*

[2] Development of the LTTS is funded, in part, through the Department of Education's Fund for the Improvement of Post Secondary Education (FIPSE) Learning Anytime Anywhere Program (LAAP) (USDE Grant P339B990108-01). For more information, see http://ltts.org.

USING COST ANALYSIS AS A TOOL FOR GUIDING AN EVOLVING PROJECT

For distance education professionals, using a cost model system can be an extremely effective tool for documenting the development and delivery costs of courses or entire distance education projects. As the following case study shows, cost analysis can also contribute to decision-making about online module development.

Cost models have traditionally been used to make a summative statement of costs. But waiting until the end of a project does not allow the outcomes of the model to feed into the project's management decisions or to facilitate timely course development. By building the cost model system into the ongoing life of the project, it can be used as a formative evaluation tool to examine issues and questions about costs, resources, and time investments as the project is being developed. In essence, this mainstreaming dramatically increases the potency of the cost model as a decision-making tool and enables staff and evaluators to monitor and reflect on the ongoing changes to the project as well as to the cost model system.

This chapter describes the changes made to one cost model system over time as well as the methods used to mainstream it into the decision-making processes of the project. The project described is a rather unusual distance education program focusing on providing online professional development modules in technology integration for in-service and pre-service teachers. The goal of this chapter is to help those who are developing cost model systems understand specific issues with regard to mainstreaming the system, such as barriers to gathering data, as well as how to deal with changes in the model as the project itself evolves over time.

About the Project and Its Evolution Over Time

In 1999, the National Center for Education Statistics found that 80% of pre K-12 teachers do not feel prepared to integrate technology into their curricula. One of the reasons cited is a lack of relevant courses for both teachers and students in teacher education programs. To meet this need, an Indiana University team has been collaborating with several partners to develop an online professional development system for teachers: *the Learning to Teach with Technology Studio (LTTS).* A five-year grant funded by the U.S. Department of Education's Fund for the Improvement of Post Secondary Education (FIPSE) was awarded to Indiana University in August 1999 to develop this system.

The goal of LTTS is to provide web-based professional development to help K-12 teachers learn to use technology to:

- Support student inquiry and problem solving;
- Develop learner-centered curriculum and teaching strategies;
- Create technology-based projects for their classrooms; and
- Teach with technology in a manner consistent with professional standards.

LTTS addresses this overarching goal through three main means:

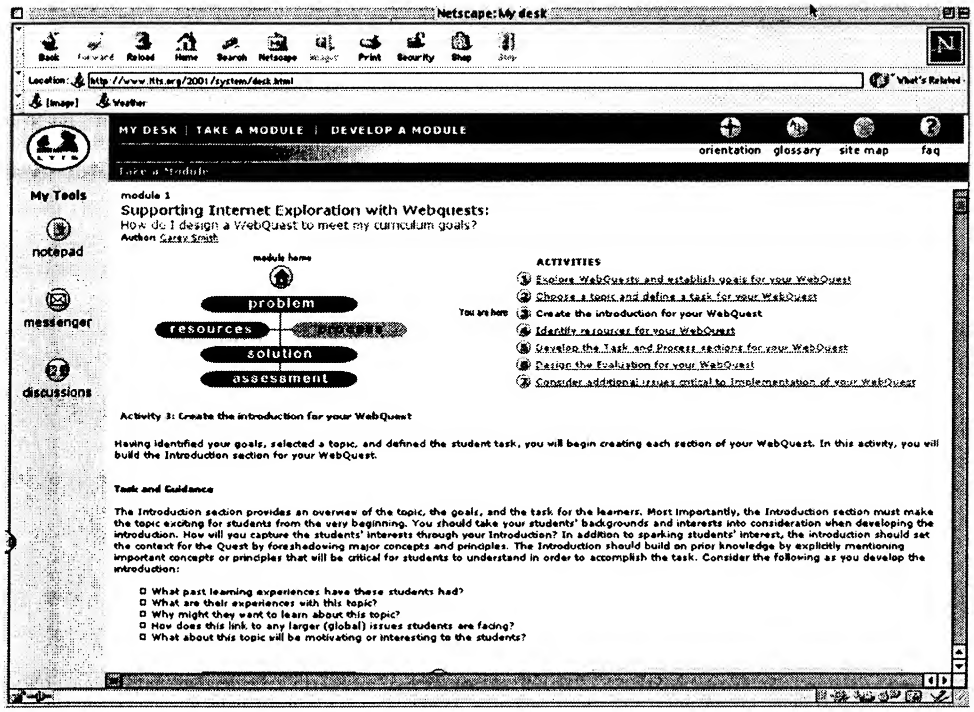
1. Offering focused, online instructional modules to teachers that focus on using technology to support student inquiry
2. Providing a support system for teachers to develop additional modules; and
3. Using an e-commerce system to scale and sustain the model.

The goal of each LTTS module is to help a teacher design and produce a technology-based project, such as a teaching unit or project plan, for his or her own course. The modules are valuable for more than just their own content: a core premise of the project is that the process of developing such modules can also help teachers reflect on their own teaching practices related to inquiry and technology and share their expertise with other teachers.

The modules are titled to address specific teacher questions such as, "How can I design a webquest to use in my classroom?" and "How can I use learning stations to integrate technology in my classroom?" (See Figure 5-1.)

K-12 teachers as well as graduate students with K-12 teaching experience develop LTTS modules. Teachers use LTTS development guidelines, templates, and other materials such as web resources on their module topic. Each module developers work with a LTTS mentor who helps him or her manage the development process. Figure 5-1 illustrates a sample LTTS module's structure.

Figure 5-1: Example of an LTTS online module



The original conception of the LTTS project was to provide a learning anytime, anywhere environment that would be highly scalable and sustainable. This would be done by high quality learning modules for individual learners in an online learning environment with no facilitators or mentors. Teachers would pay a tuition fee that would go back to LTTS with a portion to be distributed back to the module developer as royalties. Developers of modules were to be K-12 teachers with expertise in technology integration. As part of the LTTS system, teachers could develop modules to add back to the system in exchange for royalties. It was envisioned that they would use an online support system called the Design Strategy Environment, which consisted of templates and design documents as well as minimal human support. Hence, human interaction in the system was initially minimized in an effort to quickly scale and sustain LTTS with little administrative overhead.

However, after almost three years of developing the project, supporting human interaction through facilitation and mentoring has become a critical part of the online learning process as well as the module development process. We found that teachers want and need more support and feedback than originally anticipated. Rather than focusing on just individual teachers, as we had originally intended, we are now designing a mentoring system (both virtual and human) to support groups of schools and districts and teacher preparation programs that wish to use LTTS as a professional development tool. Thus, the project has evolved as a result of our findings from working with teachers, schools, and universities. For example, at the end of the project's second year, the module development process was re-conceptualized to include face-to-face workshops, online mentoring, and a modified online support system for the teacher-developers by mentors who are graduate students experienced in using the system and most have a K-12 teaching background as well.

In projects such as ours, developers constantly change as they become more aware of audience needs. Also, their skills as developers improve over time as they develop more modules, as they make adjustments to the project as it is being developed, and as they respond to new markets for the product being developed.

As strategies and developers change, cost analysis needs to change with them, and, in that process, help guide the program's evolution.

Setting Up the Activity-Based Cost Model System

From the start of the project in August 1999, the project manager used the Flashlight approach to developing activity-based cost models by using an early version (Ehrmann, Lovrinic, and Banta, 1999) of the *Flashlight Cost Analysis Handbook* (Ehrmann and Milam, 1999).

This activity-based cost model has enabled us to describe the process where resources are consumed to produce specific products or outputs. The outputs, which are created as a result of the activities, utilize a variety of resources. Fortunately, one of the authors of the original cost model document, Joseph Lovrinic, who worked as a management advisor for the Vice President and Chief Financial Officer of Indiana University, served as a mentor to the project's manager, Jamie Kirkley. Lovrinic helped Kirkley set up and maintain the cost model system. They met semi-annually to address issues specific to developing the model within the LTTS project.

LTTS used an activity based cost model approach for several reasons:

- To determine development costs for various aspects of the LTTS system;
- To allocate resources effectively and contain development costs; and
- To help evaluate the development and use of the project.

Using the Flashlight approach as detailed below, the project manager developed the cost model system used by LTTS, with input from the evaluator and project staff. The staff was always interested and helpful, although most found it a chore to track their time so systematically. Within an academic environment, tracking time on specific aspects of a project is not a cultural norm.

The LTTS project has goals similar to many development projects. Consider the following list of first year goals. Specifically, our cost model was supposed to describe the resources needed to do each of these sets of activities:

- establish the project team and the communication methods;
- establish the LTTS homepage, which would serve as a gateway to the online learning modules as well as the support system for module developers;
- hold an Advisory Board meeting to review our plans and initial work and offer guidance on strategies;
- establish an initial strategy for tagging the modules to support searching and the eventual e-commerce environment;
- perform ongoing user testing of the interface, the modules, and the design advice;
- develop ten prototype learning modules, the LTTS interface, the support system for module developers, and the definition of those design/technology constraints relevant to achieving technological usability;
- solicit developers to prepare additional modules consistent with our specifications; and
- begin to develop the marketing strategy.

An important part of setting up the cost model was to discuss it with the project team in order to get team buy-in into the cost model system. Buy-in is critical because it is important for staff members to understand how data would be collected and used. It also helps them understand that gathering data for the cost model is not a meaningless ritual—it saves them time and effort in the long run. Making sure the staff knows how data will be collected and used is a critical part of sustaining a cost model system.

Having staff buy-in and input on issues has been helping improve the development of and use of the cost model. Specifically, the LTTS team was asked to describe the types of activities they would be performing; these descriptions helped us develop the cost model. We learned quickly that it takes time for a staff to learn enough to help build and use a sophisticated cost model. We initiated a system that had many components that overwhelmed our staff, particularly the graduate students. So we decided to proceed cautiously with the pace and scale of our requests for data, hoping that we would be able to increase the complexity and power of the system over the course of five years. So far we have been moderately successful. As the staff has learned and become more committed, we have been able to improve our model. The project manager usually goes through a review of the cost model each time there are staff additions, major changes in activities, or new outputs added. Working with the external evaluator, the cost model's effectiveness has been reviewed and indicators expanded each year and some areas deleted.

Expect changes: as the project changes so does the cost model

As we tell the story of the development and use of the cost model for LTTS, it is important to note several changes in the project, which also facilitated changes in the cost model system .

First, as described above, the LTTS was originally conceived to be a pure "learning anytime anywhere" system that teachers could use individually with little interaction with an instructor or peers. Because such a system would be less expensive to operate and because costs per user would decrease rapidly as the number of users increased, it ought to be easier to make self-sustaining. However, in the first two years of the development cycle, we found that human interaction and support were critical for helping teachers work through the issues of developing inquiry based modules for adult learners. In part that was because teachers were not only learning about building modules; they were also learning the theory and methods of a new model of instruction, inquiry-based education. Also, we had underestimated the need to train teachers in how to teach their peers. We had ignored the fact that teachers most often develop curriculum for preK-12 students, not for other teachers. Therefore, LTTS module development mentors had to spend much more time than originally budgeted in order to orient new teacher recruits as well as continue to help teachers learn these three key skills throughout the development process: teaching peers, teaching by inquiry, and building online modules. For these and other reasons, formative evaluation studies showed clearly that our teacher-learners expected feedback from mentors along the way (preferably at each step), even if the teacher-learners were not taking the module for credit. So the system was redesigned to provide a human mentor (rather than an online support system) to provide appropriate and timely feedback on modules developed as part of the learning experience. Obviously, the costs of this change of project direction have been considerable. We are hoping that given this shift, we can develop a *trainer of trainers* dissemination model to defray the cost of training mentors, both locally and at sites distant from IU.

Second, major changes in project partners over the first three years of the grant resulted in substantial changes in the project's outputs as well as development strategies. In particular, the addition of *PBS TeacherLine* as a project partner added two more product outputs -- 12 modules to be licensed specifically to PBS and video vignettes to be developed and packaged with those 12 modules. Furthermore, in the second year of the grant, Indiana University took over the development of the online guidance system for supporting module development from another partner. As the partner and development responsibilities shifted, the roles of the staff also changed. All these changes in outputs and activities required making more changes in the project's cost model.

A third impact on the cost model resulted from a decision of the LTTS management to decrease the number of modules to be produced in order to put more emphasis on teacher outreach and professional development. Specifically, LTTS decided to provide professional development services and tools for a small group of schools. This generated yet another output – LTTS-based professional development programs. LTTS is currently recruiting several schools to participate in a two-year professional development effort to use and develop modules in order to meet goals for classroom based technology integration. These changes had to be reflected in the cost model as well as in the gathering and analysis of data.

Developing the LTTS Cost Model System

Every year, our cost model development (and redevelopment) has followed the same seven steps described in *The Flashlight Cost Analysis Handbook*:

Step 1. Identify the business concerns.

Step 2. Identify the outputs.

Step 3. Identify the activities.

Step 4. Identify the organizational units that participate in the production of project outputs.

Step 5. Identify the resources these units consume to perform their activities.

Step 6. Calculate the costs for these activities.

Step 7: Tally the costs of all activities to arrive at overall costs.

To demonstrate how our cost model system evolved each year, this section presents a comparison of the first three years. After we discuss the system's seven steps, we will discuss specific challenges related to mainstreaming the cost model into the project's development and evaluation processes.

<u>Step 1: Identify the business concerns</u>

The first step in building our cost model involved identifying business concerns. Identifying business issues as we began building our model helped to make project development decisions. LTTS business

concerns for the shifted during the project's first three years as depicted in Table 5-1. Note that with the passage of time, the business concerns began to shift from development to e-commerce and marketing of the program.

Table 5-1: Shifting business concerns across each year of the LTTS project

Project Shifts	Year One Concerns	Year Two Concerns	Year Three
1) Targeted users of modules: from teachers and technology coordinators to teachers and graduate students in year 3. 2) Project changed with regard to how much online facilitation would be provided. In year 3, the LTTS moved towards developing mechanisms needed to support facilitators in the system.	Instructional modules developed for K-12 teachers and technology coordinators for professional development in technology integration issues; modules designed to be learning anytime anywhere and to require no interaction.	Instructional modules developed for K-12 teachers (mainly inservice) for professional development in technology integration issues; modules are designed to be learning anytime anywhere and require no interaction with a facilitator.	Instructional modules developed for K-12 teachers (mainly inservice) for professional development in technology integration issues; modules are learning anytime anywhere but require support and interaction from online facilitator.
Note the shift from a fully online support system to a combination of online and face-to-face.	Online design strategy environment for teachers who want to create these modules. This system was to provide an online performance support system including guidance, strategies, and tips.	Face-to-face module development system with some online mentoring and mostly paper-based templates to support developers.	Mixed model of module development including both face-to-face mentoring and online guidance documents and templates to support developers as well as their mentors.
Originally we intended to simply to sell modules (e-commerce). After a while we realized we would also be using them for distance learning, so we also incorporated a course delivery system including personal learning tools (discussion forum, etc.)	E-commerce system for creating a self-sustaining environment. We began development of a main homepage so users would have a gateway to the courses. (Note: During the first year, we could not even define the parts of the e-commerce system. So this was not an appropriate output for this time period.)	LTTS learning system for managing course delivery and learning. We began developing a learning system to support delivery of the courses because commercial systems were not adequate for our goals. Our system included a discussion forum, internal messenger system, notepad, and a personalized and password protected "My Desk" area to track modules in progress and modules completed for each learner. We also refined the main portal to include a module tour, catalog, and news and events	LTTS system for managing course delivery, learning, and communication with e-commerce components to support online purchases of modules. This now involves a system for delivering the courses, enabling communication among learners, supporting facilitators, and supporting the administrative and facilitator functions of LTTS. The e-commerce system consists of a module catalog, enrollment system, and a method for purchasing modules online. (Note: The process for awarding royalties is still under development and is still undefined.)

Step 2: Identify the outputs

Next, we identified the products to be developed. Our description of products shifted over the three years of project work, as Table 5-2 illustrates. Notice that the shifting names of outputs provide clues to the changes in directions of the project. For example, the name "Learner's Studio" was chosen in year 1 to represent a place where learners could create things (in keeping with the focus of LTTS on developing a set of modules to use in the classroom). The later name "Learning Module Environment" reflects a more holistic view of the process of module development, including such tools as MyDesk. The final name, the "Learning Module System," represents the modules, the delivery system, and all the tools (e.g., discussion forum, notepad) that go with it.

As the project changes over time, it is natural for outputs to change. For example, while not envisioned during the first year of the project, additional funding from PBS was generated at the end of the first year to produce video vignettes, which added another product. In year three, LTTS began offering modules to learners online, so Learning Module Usage was added as an output. Costs associated with usage of the modules were differentiated from development because we wanted to address the question of how much it would cost to maintain facilitators and administration to deliver the modules to teachers. In the beginning, LTTS staff reluctantly understood the need for cost modeling, at least in theory. As time went by, however, staff began taking part in a proactive process that asked them for suggestions and refinements in the description of outputs.

Table 5-2: Outputs occurring during the first three years of the grant

Year One Outputs	Year Two Outputs	Year Three Outputs
Administration	Administration	Administration
Learner's Studio	Learning Module Development	Learning Module System
Developer's Studio	Design Strategy Environment	Developer Support System
LTTS Portal	Main LTTS homepage	PBS Modules/Videos
		Professional Development
		Learning Module Usage

Step 3: Identify the activities

The third step in implementing the Flashlight cost modeling strategy was to identify the activities that go into developing LTTS outputs. Activity analysis actually has two parts:

1) Identifying the individual steps needed to produce an output (step 3, described here); and
2) Identifying the organizational units and people involved in those steps (step 4, described in the next section).

To help gather this data, we asked each employee to complete an 'activity tracker sheet' every week in order to document where that employee's time was invested. At the start of the project, staff kept track of this data in a word processing document; the project manager collated the data manually. Now (in year three), each staff member completes a timesheet using Excel once a month rather than once a week. The project manager copies the data from each timesheet into her master spreadsheet, which eliminates all data entry and enables examination of costs during development cycle rather than only at end of it.

While the theory of cost modeling was easy to grasp by project management and evaluation team, the nuances required for implementation were not. While not readily apparent when we first adopted the cost model, there were several challenges with developing activities for a cost model:

- knowing which questions you will need to ask and collecting data that will enable you to answer those questions;
- collecting data at the proper level of detail; and
- collecting data in a format that will be useful.

Specific examples of this are discussed in more depth in the section titled *Barriers and Challenges to Mainstreaming*.

Activity tracking sheets became increasingly sophisticated as staff members grew accustomed to the cost model and became open to keeping records of more detailed tasks (e.g., research versus usability). Tables 5-3 and 5-4 show how we have evolved in just the first two years alone. However, we have learned that this is a gradual process. First, we had to gain a better understanding of how the project was developing overall. Second, it took time for the staff and project manager to learn to manage the process. In short, we could not have accelerated to the Year Three Activity Sheet during the first year.

Table 5-3: Year One LTTS Cost Model Activity Sheet

Name ____________________ **Week of** ___

Note: Meetings should not be counted in administrative time. Please break up meeting times by topics covered below.

Administrative	**Hours**
Gen admin (email, clerical)	
Planning & mgmt	
Computer/server maintenance	
Publicity/presentations	
Budgeting/cost model	
Evaluation	
Professional Development	
Advisory board	
Paid time off	
Other ----- System flowchart	

LTTS Portal	**Hours**
Develop content	
Design interface	
Develop portal (html, java)	
Design graphics	
Programming	
Usability/Review	
Research	
Develop multimedia	
Other: ____________________	

Learner's Studio	***Hours***
Design instruction	
Design interface	
Develop modules (html, java)	
Design graphics	
Programming	
Usability/Review usability/plan	
Research	
Develop multimedia	
Other: ____________________	

Design Strategy Environment	**Hours**
Design instruction	
Design interface	
Develop DSE (html, java)	
Design graphics	
Programming	
Usability/Review interview notes	
Research	
Develop multimedia	
Other: ____________________	

Note: (This is where you put notes on tasks in which you do not know how to categorize.)

Compare Table 5-4 with Table 5-3 to see how the cost model changed, reflecting the changing concerns, outputs, and activities. We have noted in bold those activities that are common to the first three years of the grant order to be able to compare how the system changed and became more complex.

Table 5-4: Year Two LTTS Cost Model Activity Sheet

Staff Name: __________	Hours
Time Category	
1. Output: LTTS Portal	
1.1 Develop content	
1.2 Communicate with LTTS staff	
1.3 Plan and manage	
1.4 Design interface	
1.5 Develop portal (html, java)	
1.6 Design graphics	
1.7 Programming	
1.8 Conduct usability/Review	
1.9 Conduct research	
1.10 Develop video/**multimedia**	
1.11 Develop IMS meta data	
1.12 Develop design documentation	
1.13 Other: ____________________	
1.14 Other: ____________________	
1.15 Other: ____________________	
SUBTOTAL	

2. Output: Learning Center	
2.1 Design instruction	
2.2 Edit modules	
2.3 Tutor LTTS developers	
2.4 Develop/conduct quality control of modules	
2.5 Design interface	
2.6 Develop Learning Center content	
2.7 Develop modules (html, java)	
2.8 Design graphics	
2.9 Program components of Learning Center	
2.10 Conduct usability/Review	
2.11 Develop video/**multimedia**	
2.12 Conduct research	
2.13 Develop design documentation	
2.14 Other: Programming	
2.15 Other: ____________________	
2.16 Other: ____________________	
SUBTOTAL	

3. Output: Production Center	
3.1 Design instruction	
3.2 Design interface	
3.3 Develop DSE (html, java)	
3.4 Design graphics	
3.5 Programming	
3.6 Usability/Review interview notes	
3.7 Research	
3.8 Develop multimedia	
3.9 Other: ____________________	
3.10 Other: ____________________	
3.11 Other: ____________________	
SUBTOTAL	

4. Output: Administrative	
4.1 Gen admin (clerical)	
4.2 Planning & mgmt	
4.3 Computer/server maintenance	
4.4 Publicity/presentations	
4.5 Budgeting/cost model	
4.6 Project evaluation **--collect data & analyze & review** **--prepare annual reports**	
4.7 Professional development	
4.8 Advisory board meeting/communication	
4.9 Partnership activities	
4.10 Marketing/business development	
4.11 Paid time off	
TBD: prepare developer training materials, edit training prototypes,	
TBD: recruitment, enroll students/developers, confirm registration, monitor retention	
4.12 Other: flyer development	
4.13 Other: training	
4.14 Other: ____________________	
SUBTOTAL	
TOTAL	
5. Comments	

Table 5-5. Organizational units that participate in the production of outputs

Person/unit/ organization	Activities & tasks	Project manager	Director	Clerical	Developer	Programmer	Other

Step 4: Identify the organizational units that participate in the production of outputs

Next, we identified the organizational units (and the people in those units) who perform these activities and tasks in order to produce our outputs. We used Excel spreadsheets with rows listing the activities and tasks identified and columns identifying who performed these activities. The result was a two-dimensional matrix such as in Table 5-5, showing where individuals or offices took part in the same activities and tasks. When you create your own model, you can expect that these "units" will shift each year as staff and partners change.

In order to create the cost model, we had to persuade specific partner groups to participate. University of Colorado at Denver and University of Georgia both had to participate in the cost model because they were helping develop various aspects of the project. Therefore, their staff also completed activity sheets. However, for organizations that did primarily one activity (such as IMS Global Learning Consortium, Inc., which developed the meta-tag system for our modules), activity sheets were not collected. At the end of the year, the overall cost for these organizations was calculated into the cost model system as a development cost. For example, we were interested only in the overall cost of meta-tags and not with costing specific activities for those development efforts. Because the meta-tag component was not a major output, it was not necessary to gather detailed development costs. Learning where we did not need detailed information on costs was important because it saved time in data collection and analysis.

Step 5: Identify the resources these units consume to perform their activities

The next step is to identify the resources these units and individuals use to produce outputs. Examples of resources include:

- Compensation such as salary, retirement contributions, and benefits;
- Expenses like staff consume such resources as supplies, room space, phones, travel, lodging, equipment purchases or rentals;
- Direct allocations including both compensation and expenses; and
- Hidden costs such as building and equipment depreciation and the cost of legal services provided by university at no cost.

For example, these costs might be calculated to include the indirect costs taken by Indiana University to provide building space, office supplies, administrative support, and legal services for developing module developer contracts.

Step 6: Calculate costs for these activities

After identifying business concerns, outputs, activities, and resources and determining the metrics by which to quantify them, step 6 uses these data to calculate the costs of the various activities and tasks involved in producing the outputs.

Table 5-6. Costs born by each organizational unit

Cost area	List for each organization involved				
	A	B	C	D	E
Payroll					
Benefits					
Supplies					
Equipment					
Xeroxing					
Postage					
Total					

The Economic Model is a flexible strategy and we needed the flexibility. A more typical approach to costs relies on asking how many hours or days a week each person works on a project, and using that to calculate a fraction of their total salary to be allocated to this set of activities. But in our project, production relies on teams of teachers and graduate students who do not work full-time or even standard hours. It made more sense for us to work from logs of actual time spent on the project.

Step 7: Tally the costs of all activities to arrive at your overall costs

Each time we go through Steps 1 through 6, we create matrices that separately analyze compensation, expenses, direct allocation, and hidden costs for selected activities and tasks. To arrive at our overall costs, we then tally the costs derived from these individual matrices. This involves putting all the pieces together – each staff member's activities, each of the resources consumed, and each organizational unit's overall picture. We also add in indirect costs. When all costs have been calculated, the total should equal the expenditures for the year.

Special Challenges with Calculating Costs

The LTTS project has encountered two specific challenges with regard to calculating costs: accounting for overtime and accounting for 'in-kind' contributions.

Technically, since we are not paying for this overtime, we can treat it as in-kind costs. However, instructing staff members on how to document these activities has proven challenging. For example, if the project manager worked ten hours of overtime, which activities should she list as cost versus in-kind? Capturing these costs is critical because these unaccounted activities can have a real impact on the overall development picture. At this point, we have not addressed this issue very well and continue to struggle with how to collect and use this data.

The second issue relates to in-kind costs. Since LTTS is a federally funded project, there must be a dollar of in-kind match for each dollar received from the US Department of Education. This amounts to quite a bit of in-kind contributions. For example, each advisory board member contributes one to three days of time each year to review specific products. Several partners contribute computer equipment and software as in kind contributions. While we have documented in- kind costs each year for purposes of reporting to our funding agency, FIPSE, it has taken us three years to incorporate these costs into the cost model. While these in- kind activities do not have to be funded from our grant, adding them to the cost model helps us better understand the whole development picture.

Barriers and Challenges to Mainstreaming the Cost Model System into the LTTS Project

Over the last three years, we had to meet challenges to the mainstreaming of cost modeling into the daily life of the project. Some of these challenges may well reflect difficulties that other cost modeling projects will face, especially if the process is meant to be part of day-to-day decision-making. Below, we discuss some of the serious barriers to mainstreaming, including: technical issues with gathering data across multiple sites, using the system to ask "appropriate" questions and gather "appropriate" data, attending to the scalability and dissemination factors of the project, and ensuring team buy-in to an evolving system that becoming increasingly demanding of staff.

Technical issues with gathering data across multiple sites

Consider our odyssey below:

> In the beginning of the project, each staff member completed a weekly activity sheet in Microsoft Word. The staff member would mail it to the project manager, who would input it into an Excel spreadsheet. This system worked fine for a few months when there was a total staff of four. However, as the project staff grew, doing each person's data entry by hand became too time-consuming. Also, the room for error in having to transfer numbers from a Word form to an Excel spreadsheet was also a problem. To improve data gathering techniques, an individual spreadsheet was set up so that each staff member could tally his or her activities. This was then posted to a server for the project manager to obtain. However, this still took time as the project manager had to transfer each person's numbers to a master Excel spreadsheet. Finally, in the third year, another improvement was made that seems to work well so far. Each person received an Excel spreadsheet where the entire year's worth of activities can be tracked. There is a separate worksheet for each month, and a master worksheet to compile all the hours for each activity. So there is no data entry, cutting and pasting of numbers, or transferring of data. Each employee's spreadsheet is submitted monthly and is tallied into the master set of cost model calculations. Employees still submit these spreadsheets monthly, and the project manager reviews them to see if they are on track or if new issues are arising due to needing new categories. This has been one of the best improvements made to our system. Follow-through is much easier since the hours for compiling and aggregating data have been reduced.

The number of developers and partners continues to grow. While this is a distinct asset, the metaphor of herding cats comes to mind. Data collection needs to be streamlined so there is minimal overhead associated with data gathering. Thus, we are learning to avoid the transfer from text to spreadsheets and all the error checking required of the first year process. Currently, it is our goal to enter and review monthly so that questions can be answered during the development cycle and not at the end when it is too late to help program-improvement decisions. However, the project manager still finds it challenging to make time to do this. Having an automated system (e.g., online web page where data could be entered and then assimilated) where staff members could enter their time and activities into a database that could then be aggregated into a report would relieve her of the tracking duties and enable her to focus on simply reviewing the data to use in decision-making.

Using the system to ask "appropriate" questions and gather "appropriate" data

One of the most important things to understand about the cost model is that data is not gathered just for the sake of gathering data—the goal is for the data to help answer specific questions about the project development. The economic model has helped us become aware of significant questions that we must face to succeed. In the past three years we have faced a variety of questions that have shifted our cost model even more. For example:

1. *How to build a "joint vision" between two teams in two different locations.* As many multi-site projects experience, translating the rhetoric of the original proposal into the reality of activities tests the assumptions of a grant's designers. Given the highly theoretical tenets of the project dealing with definitions of what "inquiry learning" is, during the first year the two separate development teams discovered they had slightly different definitions of what "inquiry learning" meant, designed modules without calibration assuming they were using identical processes, and at a mid-year meeting discovered the dissonance. Cost model use in the formative phase was not fully in place the first semester of the project so we could not use it as a detector. When we expanded to another university to increase the scalability of our module production, we used what we learned from the first year, and put more specific outputs into the cost model that this university was using to document progress and was able to calibrate faster given the cost model monthly data.
2. How to build buy-in to the cost model system when the project is being developed at two different sites?
3. How to capture development of the e-commerce model as it becomes clearer over time?
4. How do we monitor the costs of the various teacher developer training models (and hybrid

models) that are emerging (e.g., face-to-face versus online training or a mixed model)

5. What are the cost components of module developer recruitment?
6. How do we reduce the time it takes to put modules online and deal with an ever-increasing database of resources to manage?
7. What are special issues of rapid prototyping—should and how can redesign and redevelopment be tracked?

We have found, at times, that we were not collecting data at the level that would enable us to answer specific questions. For example, we tracked only the costing of module development in general and not the specific costs it took to develop each module or even parts of a module. Later on, we realized that having details about those specific costs could have helped us determine the most efficient development methods (e.g., would it be more efficient to use in-service teachers as developers or graduate students with teaching experience as developers). In year three, we are beginning to mainstream this increased detail into the project; that has helped us revise the cost model to include the time it takes graduate student developers (versus teacher developers) to complete each of the ten development steps. However, gathering this detail data continues to be challenging; consultants resist tracking their time spent on projects.

Another challenge has been dealing with the appropriateness and consistency in how data is recorded. For example, a web developer and interface designer may work on the same component of the system but record them under different outputs. This confusion often relates to where boundaries are drawn in the development of our system. For example, the *MyDesk* feature, which helps learners track which modules are in progress and which are completed, is both part of the learning module environment and is also part of the LTTS portal. In reflection, the *MyDesk* system should have been made a separate output within the cost model system in order to track specific costs and to avoid confusion. In the meantime, the staff has to decide under which headings to record these activities. It helps to have a *Notes* section on the timesheet; an employee can indicate when they are having trouble putting something into the proper category. The project manager can then decide how to categorize that period of time.

Specifically, making sure that data is systematically collected, analyzed, and reported is one of the critical issues faced by our project and any project doing a cost model. For the staff involved in analyzing data, the cost model is just one of the many things they do. From the evaluation perspective, it is helpful to require the cost model data from program onset so that there is an outside impetus to report on the model at least bi-annually for this project.

Another issue related to gathering and aggregating data is determining the level of granularity at which data needs to be collected. For example, we are currently discovering that multiple levels of module development are an important consideration for future production decisions. We will use the cost model during the summer 2002 to collect answers to issues such as:

1. On the average, how much time is required for developing a whole module;
2. How much time does it take each developer to complete each of the 10 stages of module development;
3. How much time does it take each mentor to critique each step that developers complete;
4. How much time does it take for developers to complete their second modules compared with their first modules? That would give us an indication of the learning curve of developers as well a hint about their comfort level and motivation to participate in future development efforts;
5. At what steps should mentors give feedback in the development process given an analysis of the completion rate differentials;
6. How much does the level of complexity of module objectives and the type of content (e.g., linear topics such as explaining how to use Geometer Sketchpad versus non-linear topics such multicultural technology applications) affect the length of time of project completion as well as the expertise of developers; and
7. How much time is required by teacher developers compared with graduate student developers?

To gather this kind of detailed data requires making the cost model a regular part of the monthly project evaluation processes. Also, it is important to try to incorporate additional questions that arise as the project evolves. At times, additional outputs and activities will need to be added to the activity sheet, so anticipating these is helpful for making sure that appropriate data is gathered as the new activity begins. For example, the addition of the PBS video vignettes to this project added another output for the

project. This part of the project required additional staff, resources, and project coordination. Therefore, it should have been added to the cost model system sheet before the work began.

Since the project has used a rapid prototyping method of development, it can be challenging to answer questions about phases of development. It is sometimes difficult to distinguish between versions, because the process of development can blur from one version to the next. Thus time spent on particular versions has proven to be difficult to capture for the project. However, we realize if we are really committed to testing how well a cost model can be mainstreamed into our management process, we must address this challenge as well.

How to ensure team buy-in to an evolving system that becoming increasingly demanding of staff

Lastly, gaining staff input and trust in the model is a critical part of the cost model development. Staff input is a critical part of helping determine the activities to document and questions to be asked. After all, it is the staff that often has questions about the effectiveness of specific development methods. We have discovered the following strategies:

- Establish buy-in early on at multiple development sites;
- Address staff concerns with use of cost model system;
- Invite staff reviews of the model and solicit regular input into the activity sheets—unilateral requirements to use the model are ineffective and result in inaccurate data. The staff must feel like they are building the model and understand how it is constructed;
- Demonstrate that the findings are being used to improve the project;
- Early on, anticipate and deal with participant fears of personal tracking, which can distract from project focus to document costs of activities and outputs; and
- Be sensitive to the semiotics that surrounds this effort of cost modeling and the possible loss of the "human factor" and creativity of staff. For example, we changed the term "timesheets" to "cost model activity sheet" to break the negative connotation of timesheets.

Summary

In this chapter, we have discussed a range of issues with implementing a cost model within the LTTS project case study. These issues all relate to the experience of implementing and using a cost model as a formative evaluation tool within a distance learning project. Perhaps one of the most challenging parts of developing a cost model is helping the staff reach the understanding that it is a living and breathing entity that changes as the project changes. Therefore, it is critical that the cost model system be mainstreamed into the decision making process of the project. This not only enables project administrators and staff to make more effective development decisions, it also helps staff members understand the administrative issues with regard to project development.

With the rapid growth of distance education, the cost model system can be an effective system for monitoring costs and guiding project or course development. However, unless barriers are addressed and the cost model is integrated into the project, it will not be as effective. However, the major issues with mainstreaming lie in the time investment and barriers that need to be addressed by the cost model manager. Thinking through the possible barriers beforehand will enhance the effectiveness of the cost model as a tool. A final consideration is that the cost model is never done—it needs to constantly evolve to meet the needs of the project.

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CASE STUDY 6:

WASHINGTON STATE UNIVERSITY

A COST/BENEFIT ANALYSIS OF THREE TECHNOLOGY DEVELOPMENT STRATEGIES IN HIGHER EDUCATION USING THE FLASHLIGHT ECONOMIC MODEL

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Abstract – *Better information about the efficiency as well as the effectiveness of new technologies in higher education is essential, especially given the current rapidly changing environment in higher education. Washington State University has conducted a focused project using the Flashlight Economic Model to analyze the cost of three approaches to the development of learning technologies. This article has two purposes. First, to examine the effectiveness of the Flashlight Economic Model and the activity-based costing techniques it is built upon. Second, to present the results of the study that compared the costs of developing an online course, a stand-alone interactive module, and a template for Web-based computer conferencing. It appears the Flashlight Economic Model can be implemented without creating a "mudslide of data" and without special software. The WSU study also indicates that information from the model has the potential to be very useful.*

Revised June 1999 for the purposes of this Handbook

INTRODUCTION

Since ignoring new technologies in higher education is not an option, educational institutions across the country are now searching for effective strategies for investing in new technologies. No strategy promises to be cheap. The challenge is to find or develop approaches that are effective relative to cost.

To determine the cost effectiveness of new technologies in education, the common approach has been to *compare* the costs of distance approaches to education with the costs of traditional education. The premise of the study reported here, however, holds that such a perspective, certainly for a rural, residential campus like Washington State University, is irrelevant. Online education is a competitive reality. We do not need to explore *whether* distance education is cheaper: we need to learn *HOW we can accomplish it effectively* –which necessarily includes consideration of costs.

At WSU, like many institutions, we have tried several investment strategies for developing and integrating technology, usually simultaneously. Among them, a recent campus-wide Request for Proposal (RFP) process provided a good opportunity to assess three distinct approaches to technology investment. Two of the projects (or technology models) analyzed came from this RFP proposal while an instructor independently developed the third.

1. The "modular approach," (InterFon™) targets one topic (phonemes) with the notion that the module might serve as a part of several courses. The development team included two content experts and one professional programmer from the Center for Teaching & Learning.
2. The "Web-based conferencing template" (WebSeminar) allows faculty from any discipline to paste materials and assignments into the web-conferencing template and then facilitate the threaded discussions evolving from posted assignment. The development team included three professionals from The Center For Teaching & Learning and their partner unit, The Student Advising & Learning Center, as well as a number of student interns or hypernauts.
3. The "single class model," (Teaching and Learning 445 or "T&L445) was developed by a single instructor of educational technology who already possessed both the resources and the

expertise to put a single, complete course online without the benefit of the granting process.

The three models represented in this study, then, establish the context of the technology development strategies and shape the fundamental business (or cost-effectiveness) question: ***Which approach for developing online learning opportunities provided the most cost effective model for integrating technology into the university?*** As a critical qualification, we assumed, for the purpose of this study, that the quality and quantity of learning is held constant and subsequently qualify "effectiveness" as the least cost per volume of student use. This analysis did not address the larger aspect of benefits – *learning* – or the innumerable variables such a qualification entails. Clearly, a cost analysis will be significantly augmented when coupled with other approaches to assessment – including other Flashlight tools like the Current Student Inventory, the Faculty Inventory, and other planned assessment tools like the Alumni, and the Community surveys.

The Problem: Costing Three Technology Development Strategies

To answer the question about the efficiency of the three different development strategies, we also have to recognize that each of the technology approaches reflected a correspondingly distinct instructional implementation strategy that informs the analysis as well:

1. The modular approach that targets a key course concept is designed for a single unit within a few Anthropology courses that focuses on teaching phonemes, the fundamental building blocks of language. In other words, the project would be used, *by design*, for only a few weeks during a single semester in any relevant course or courses.

2. The web-based conferencing template was initially designed for and implemented in WSU's Freshman Seminars, which included 25 introductory classes that were linked to general education courses. The linked courses, as it turned out, provided a good method for expanding the use of the web-based computer conferencing software because the companion courses, learning of the technology, often adopted the technology.

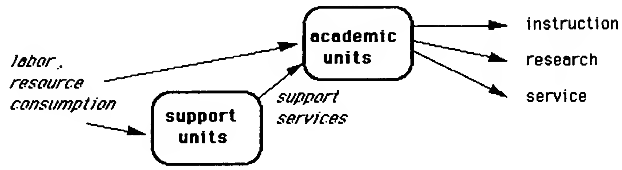
3. The class conversion approach was used by an instructor in educational technology who asked students to read essays on technology in education and then e-mail responses to him from a designated window on the Web. The course design included graded responses, assignment sorting by dates, and other course specific features. The notable aspect of the class conversion approach in this study was that the design of this educational technology course for the Web integrated the course content with the technology being studied. In that sense, the course conversion reported here reflected a particularly comprehensive integration of a course for teaching online.

The Method: The Flashlight Economic Model

We adapted the Flashlight Economic Model to do the cost analysis study. The economic model has been developed as an evaluative tool as part of the Flashlight Program. The Flashlight Program was developed under the direction of Steve Ehrmann with a grant from FIPSE and Annenberg CPB to help educators assess new technologies intended to enhance and extend learning. Flashlight provides a suite of assessment tools like the Economic Model and the Current Student Inventory, as well as training, consulting, and other services. The Flashlight Program is now housed with The Teaching and Learning with Technology Group (TLT Group), an affiliate of the American Association for Higher Education.

The Economic Model used in this study is a "...decision support tool which utilizes activity-based costing techniques to analyze the costs of campus outputs" (Thomas and Lovrinic, 1994). An activity-based costing (ABC) system models the usage of an organization's resources on the activities that use these resources and then links the cost of the activities to outputs or products (Lewis, 1995, p. 50). Figure 6-1 from the Flashlight Economic Model guidebook (Thomas and Lovrinic, 1994) illustrates these "links."

Figure 6-1: Organization-wide linkage of costs to activity units



The major difference between activity-based costing (ABC) and other accounting systems is that in an ABC model the resource costs are linked to activities rather than some other unit. For instance, teaching is an activity, and salary is the traditional cost measure associated with teaching. In education, however, just teaching may not accurately reflect the endeavor of developing an online course (see Table 6-1). ABC isolates the appropriate activities involved within a targeted study – such as integrating technology into teaching – and thereby provides organizations with a better understanding of the particular costs involved in that activity and a how to link those costs to the particular outputs being studied. By isolating the particular activities within a process, ABC also provides improved metrics and a better understanding of complex business processes and the associated costs. For example, results from this analysis revealed that as projects mature the percentage of resources spent on revisions and maintenance increases. This information has been useful for planning for the maintenance expenditures of future projects.

The Traditional Accounting "view" vs. The Activity-Based Costing "view"

The traditional view lists costs (or expenditures) by "general ledger account" while ABC categorizes costs by "activity units." Allocating some costs can be relatively straightforward, e.g., the amount of time a person spends on each activity. Other allocations can be more difficult, e.g., an algorithm to correctly allocate capital costs.

Table 6-1: Example of the traditional accounting "view" vs. The Activity-Based Costing "view"

Department "X" traditional view		**Department "X" ABC view**	
Salaries	$30,000	Instruction	$20,000
Benefits	7,000	Research	15,000
Supplies	3,000	Service	15,000
Equipment	10,000		
Total	**$50,000**	**Total**	**$50,000**

Seven Steps of the Flashlight Economic Model

Seven basic steps are recommended to implement the economic model. However, "each institution is encouraged to modify these steps to fit their particular needs" (Lovrinic, Ehrmann & Banta, 1999).

1. Identify your business concerns and the specific questions you want answered.
2. Identify your outputs.
3. Identify the activities that go in to producing your outputs.
4. Identify the academic and support units that produce your outputs.
5. Identify the resources these units used to produce your outputs.
6. Calculate costs for these activities using financial data about your resources: salaries and benefits, costs for supplies and equipment, building costs, and depreciation.
7. Tally the costs of all activities to arrive at your overall costs.

<u>Step 1 – Identify business concerns and the specific questions you want answered</u>

The fundamental business question at WSU, framed by the three models studied, was to determine which approach for developing online learning opportunities provided the most cost effective model for providing technology-enhanced and online instruction.

<u>Step 2 – Identify outputs</u>

Outputs refer to the endpoints or constructs of the study. The outputs in this study surfaced the conflict between adding outputs to the model to increase the accuracy of the model, vs. limiting outputs to the model to constrain the study for purposes of practicality. For this analysis, the outputs were determined by the specific business question – the three development strategies: the module-based approach to technology development, the whole class conversion approach, and the web-based conferencing template approach.

Defining the characteristics in each output that are similar and those that are different was essential in order to identify the activities involved in producing each output.

The module approach: Required two faculty content experts and one programmer, hardware and software, targeted one learning concept for one class for a limited period of course time, with the possibility of further distribution into other courses later.

The class conversion approach: Required only one faculty with expert technology skills, hardware and software, targeted an entire 15-week course.

The web-based conferencing template approach: Required a design team, one lead programmer and several student assistants, hardware and software, and targeted an indefinite number of courses over an indefinite and flexible period of time.

However, determining the level of detail in which to examine each of the outputs proved to be problematic, since each output studied had "more particulars than generalities," making it difficult to draw generalizable comparisons. Nonetheless, the process of analyzing these outputs raised some valuable questions that provided insight into further analyses and strategies for developing and integrating technology into instruction.

<u>Step 3 – Identifying activities required to produce outputs</u>

The Flashlight Economic Model provides for flexibility and may be useful for a variety of studies, ranging from the comparison of newly adapted technologies, instructional training time, and others. Each study shapes the business question and the subsequent activities analyzed.

There are several other considerations at this step. First, the design needs to address enough activities to distinguish between the outputs or projects. However, if too many activities are used, the distinction between them blurs. Another consideration is that different activities in activity-based costing may have different cost structures. For example, planning may be a different activity than implementing for several reasons; planning may not require actual teaching activities or the use of teaching assistants or classrooms but may require the purchase of software, the use of technical experts for programming, etc.

Different models of "courseware engineering" and/or "instructional design" may be helpful when trying to determine activities for developing courseware. One of the first steps when conducting a study such as this required developing an "activity dictionary" listing the activities considered with definitions of each.

The WSU study limited the number of activities because the analysis began after the new technologies and courses were either developed and in use or in the prototype stage. The estimated hours and other resources spent on each activity had to be determined

Table 6-2: Estimated hours spent by key developers for each activity

	Design & Prototype	Implement	Revise & Maintain	Total
Person A hours	68	346	1,166	1,580
Person B hours		346		346
RA, TA time	-	42	123	165
TOTAL	**68**	**734**	**1,289**	**2,091**

by post hoc interviews. The number of activities was therefore kept at a minimum to help the developers and content experts make clear distinctions and provide reasonable time estimates. It was decided to limit this economic model to three main activities: (1) design and prototype, (2) implement and (3) revise and maintain. The final model deviated slightly from strict adherence to activity-based costing. Some of the direct costs were allocated by activity determined by a series of extensive interviews and examination of applicable grants and other documents. However, some indirect expenditures were allocated on a "per-hour" basis, which did not reflect the fact that different activities probably used these resources at differing rates.

Step 4 – Identify the units that participate in the activities

Once activities are identified, the units involved in the production must be identified as well as the people in those units who performed the activities and tasks in order to produce the outputs.

Table 6-2 gives a simple example of the activities in columns. The rows identify who performed the activities. The result is a two-dimensional matrix that shows how several individuals and/or offices take part in the same activities and tasks

This example illustrates how different staff levels are involved. Person A could be a content expert while Person B could be a courseware developer. It is quite common to have a mix of courseware developers, content experts, and student or part-time labor involved in one project or even with one activity. At WSU, the units where most of the time accumulated for each course include:

- WebSeminar included two major "units," The Center for Teaching and Learning (CTL) and the Student Advising and Learning Center (SALC),
- InterFon™ was produced by the CTL and the Department of Anthropology,
- T&L445 was produce by the College of Education.

Step 5 – Identify the resources the units consume in their activities

The next step is to identify the resources these units and individuals use and apply prices to the quantities used.

There are many possible types of expenditures. The attached "WSU model" categorized expenditures using two broad categories: direct and indirect expenditures.

Direct expenditures can be traced to specific expenditures for the projects (such as hardware, software, travel, consulting fees, etc.) and also consist of payroll, i.e., salary and wages from the estimated hours spent by person on each activity, including estimates for benefits. This analysis did not use depreciation to allocate the capital costs of each project over several periods; the costs of computers and software were directly "expensed" to each project to simplify the model. The useful life of computer hardware is becoming shorter and shorter and it was felt that amortizing these costs would not significantly impact the outcome of the analysis. However, the economic cost of using existing facilities (including computer hardware) was estimated by adding indirect expenditures for computing and maintenance.

Indirect expenditures were estimated for such categories as goods & services, computing services (to estimate the use of the campus Ethernet connections, etc.), telephone, maintenance and utilities. Indirect expenditures for this project at WSU included estimates for goods & services, computing (mainly for the use of the Ethernet telecommunications system), telephone (telephone support was provided for the software development packages used, but WSU still paid for phone calls), and plant & operations maintenance.Once costs and cost drivers are identified, **metrics** had to be determined, i.e., by what standards of measure (or metrics) outputs are quantified. For this study three standards of measure were identified: total cost for the project, student weeks of use, and, the key metric, "total cost per student week of use".

Step 6 – Calculating activity costs

Costs of activities will usually need to be *estimated.* Most university accounting systems do not use activity-based costing. In this way, ABC does not necessarily, (as one concerned faculty member once objected), "bury the audience in minutiae of detailed data." The amount and detail of the data can be tailored to the kinds of decisions the data and the report targets. Issues such as this are summarized in Figure 6-2 (Cokins, 1996).

Figure 6-2: Common misconceptions about Activity-Based Costing

Misconception	*Reality*
▪ ABC requires a massive amount of data and detail, plus tremendous maintenance.	▪ The level of detail, accuracy and frequency of reporting depends on the kinds of decisions the data are to be used for.
▪ ABC data must be very accurate.	▪ It is better to be approximately correct than precisely inaccurate.
▪ It is tremendous work to collect a mudslide of data.	▪ Pareto's 80/20 rule allows to significant amount of estimation from informed participants within a business process, combined with a few key interfaces to operational databases.
▪ ABC creates a separate set of financial books, which leads to confusion.	▪ Management can guide users as to which set of books to use. With time, organizations can integrate their general ledger with an activity accounting system.
▪ You cannot do ABC without special ABC software.	▪ The initial learning process can use spreadsheet software to translate general ledger data into activities.

In this study, the first step was to interview key people in each project and ask them what their major activities were and to estimate the number of hours they spent on each activity. This, as we shall illustrate, was a key distinction in the analysis process. When possible, interviewees were asked to provide records to substantiate their estimates. Still, much of the attached data are based on the interviewees "best recollection." A different interviewer may have approached the analysis differently, asked questions in a different way and may have found different (but hopefully similar) numbers. The major factor driving the costs for all of the projects analyzed was hours spent preparing, delivering and maintaining the courseware, both by content experts and technical developers. Once hours were determined, analysts could begin assigning payroll and benefits rates to compute payroll expenditures. Other direct expenditures were allocated to the projects (usually obtained from grant documents) and finally, indirect expenditures were estimated.

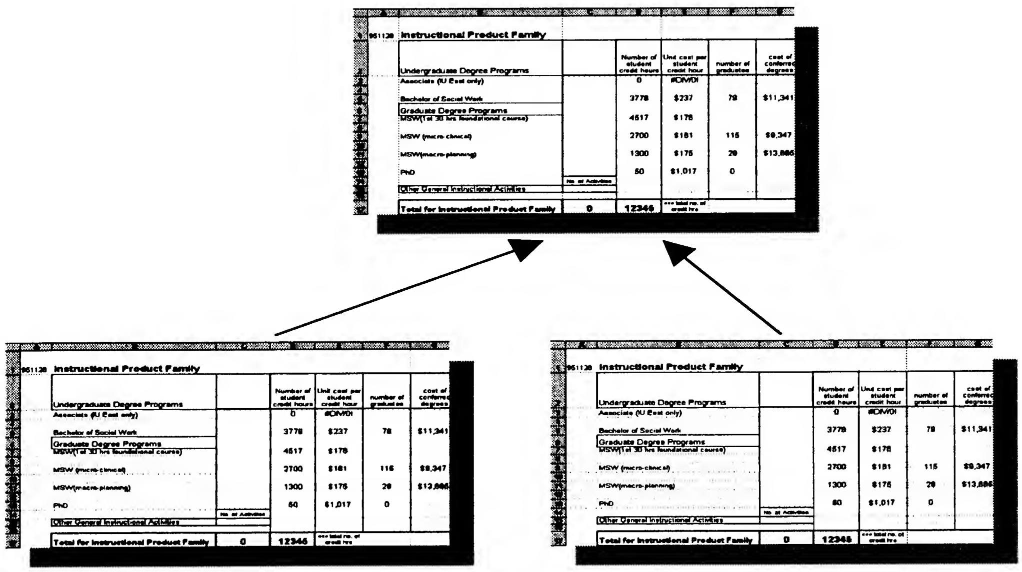
<u>Step 7 – Tally the costs of all activities to arrive at overall costs</u>

Several spreadsheets (or matrices) were used to separately analyze estimates of direct costs such as salaries & wages, payroll benefits, other direct expenditures such as hardware and software and to estimate indirect expenditures for selected activities. "Total expenditures" were derived by summing the detailed expenditures from the various spreadsheets.

We envisioned the completed economic model as a pyramid constructed of stones, and each stone as a spreadsheet or matrix. The top stone, or highest-level matrix, contained data about the total estimated expenditures for all activities. The base of the pyramid included several stones, or matrices, each of which contained the estimated subtotals of overall expenditures – by each activity and related tasks.

Figure 6-3 (from Lovrinic, Ehrmann & Banta, 1999) illustrates how we "worked up the pyramid" as subtotals were added from the lower matrices into the matrices at the next higher level. This resulted in a gradual tallying of estimated expenditures until total expenditures were attained for each activity.

Figure 6-3: Linkage of data from lower level "matrices" or spreadsheets to the top level summary report



Collecting and Analyzing the Data

<u>Defining activities</u>

The Flashlight Cost Model can be adapted to use several measures of activities. Some activities, outlined by Lovrinic (1996) include:

- developing concept/projections
- preparing course content
- preparing instructors
- preparing other materials
- marketing
- recruiting and managing enrollment
- instructing
- evaluating and assessing

Based on our experience at WSU, it may help to identify a list of activities and prepare an "activity dictionary" for use with the Flashlight Economic Model. Edward Forrest gives an example of a format for creating an activity dictionary that we reproduced in Table 6-3 (Forrest 1996).

Table 6-3: Forrest's template for an "activity dictionary"

Activity Dictionary					
Activity Name	Primary or Secondary?	Work Driver	Cost Object	Performance Measure	Comments

Determining and defining activities is perhaps the most important challenge, though identification of too many activities requires more timekeeping duties by all developers, at additional cost.

Measuring the volume of use

In his book on activity-based costing, Lewis (1996) specifically notes the implications of activity-based costing (ABC) for education. He suggests using credit hours as a measure of volume. However, the projects examined in this study, like many educational innovations, are often not used for an entire semester. Like the Carnegie unit in general, new technologies in education are continuously challenging the credit hour as the appropriate measure for conceptualizing education or educational activities.

So far, the whole course conversion strategy used for Teaching & Learning (T&L 445) has used the innovative online approach for the entire semester. However, InterFon, the technology module, was designed to be used during 3 to 5-week intervals in one of three courses. WebSeminar has been used by many courses for the entire term, but several courses used it for four-week sections. Therefore, rather than dividing activities by credit hours, we tracked volume by the number of students who used the new teaching technologies multiplied by the number of weeks students used the innovation. We called this metric "student weeks."

"Student weeks," like any metric that attempts to contextualize the use of an innovation, has limitations. "Student weeks" at any given point within a study will not reflect the potential use of a product. In this study, the use of WebSeminar (now Speakeasy) has expanded dramatically. The use of InterFon™ has expanded beyond our predictions into new applications. Enrollment and therefore the use of T&L 445 has also expanded, though obviously not into other courses.

Student weeks as a measure also fails to reflect the distinction between a two and three credit course, which may have various impact on measures of use.

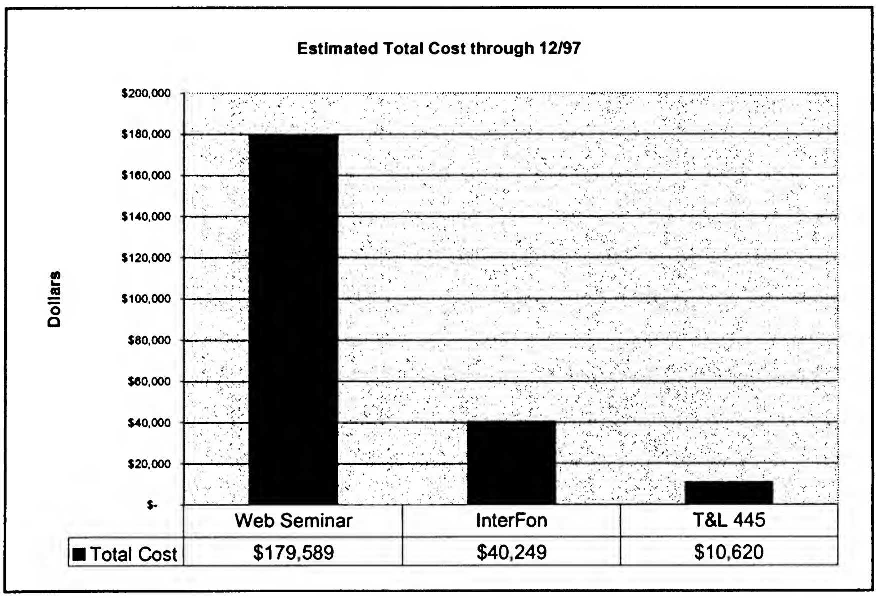
Gathering data

An additional hurdle we encountered was that WSU presently has no central repository for the kinds of data needed for this type of economic analysis, especially the estimates of cost and allocation of "indirect" expenditures. It was therefore necessary to gather data from a variety of sources on campus, including Institutional Research, the Finance Office, and other sources. We had to track down cost data by speaking with administrators responsible for capital budgeting and operating budgeting and had to access grants and RFP documents. Furthermore, it proved to be somewhat difficult explaining to the appropriate administrators the types of data needed. For example, we went to Person A, who sent us to person B, who sent us to Person C, who said we really should see Person A. Certainly some of the difficulty stemmed from our inability to communicate across various administrative discourse communities. Some of the difficulty reflects the fact that activity-based costing is relatively new (invented during the last decade). ABC originated in industry and has been adapted by "service organizations" even more recently, the Flashlight Economic Model is even newer. As educators become experienced collecting cost data they should become familiar enough with the accounting system of their institutions to find most necessary data.

Results

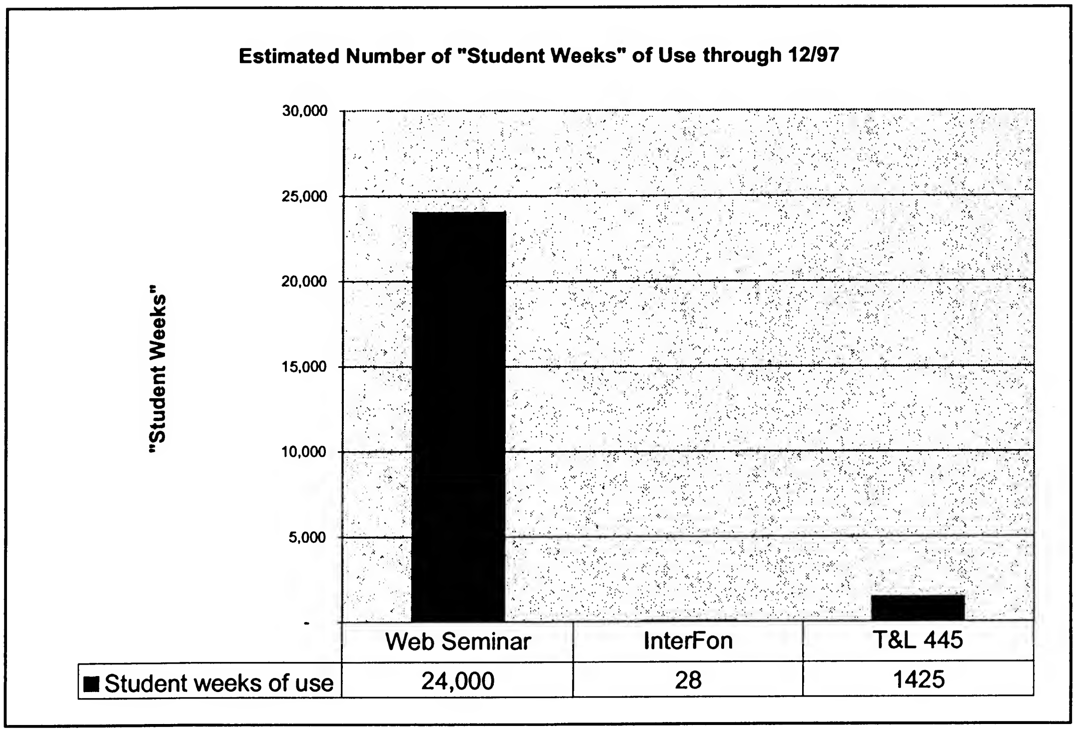
Figure 6-4 illustrates the total costs of the three projects. Please note: InterFon™ was partially funded by a grant from Boeing and also WebSeminar (now the Speakeasy Studio) was largely funded by grants from Microsoft and Boeing. The total costs estimated below do not "net out" any of the grant benefits. The cost of the web-based conferencing template, WebSeminar, was substantially more expensive to develop than the other two approaches, costing roughly $180,000 to the point of instructional implementation and reliable use. The module project, InterFon™, was the next most expensive development strategy, costing $40,000 to develop to the point of reliable implementation and classroom use. Finally, the cost of converting an entire class was the least expensive strategy.

Figure 6-4: Estimated total cost of the three projects analyzed through 12/97



However, the total cost of the projects is a misleading way to compare the cost efficiency of the three development strategies. A more accurate measure may be the total cost per unit of volume. Figure 6-5 illustrates the estimated amount of student weeks of use through the time of the initial study.

Figure 6-5: Estimated student weeks of use through 12/97

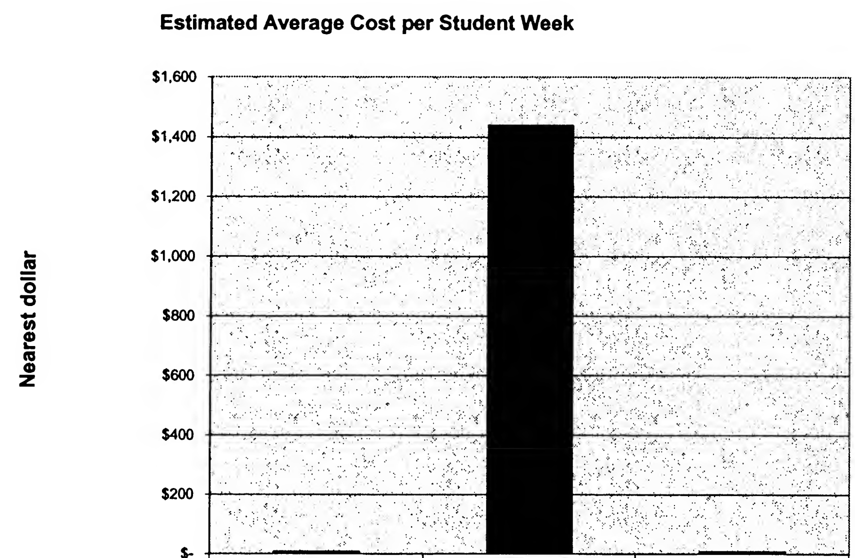


The estimated student weeks of use for the web-based conferencing template, WebSeminar, was substantially higher than the other two approaches, with an estimated 24,000 student weeks of use. The module project, InterFon, had the least amount of use, at a user level of 28 student weeks (InterFon had just been prototyped for one week in a class of 28 students). There were 95 students in the T & L course who used the online conversion for the entire semester giving a use rate of 1,425 student weeks of use.

Finally, to put the costs to develop each module and the amount of student use into perspective, we divided the cost to develop each course by the number of student weeks of use. Figure 6-6 illustrates the cost per student week of use.

The cost per student week of use for the web-based conferencing template, WebSeminar, was about $8.00 per student week, whereas the cost of the modular approach was $1,400 per student week. The course conversion also cost roughly $8 per student week of use. It had a lower initial cost than the WebSeminar but fewer students had used the online course than those who used the WebSeminar.

Figure 6-6: Estimated average cost per student week of use through 12/97



	Web Seminar	InterFon	T&L 445
■ Average cost per student week	$7.5	$1,437.5	$7.5

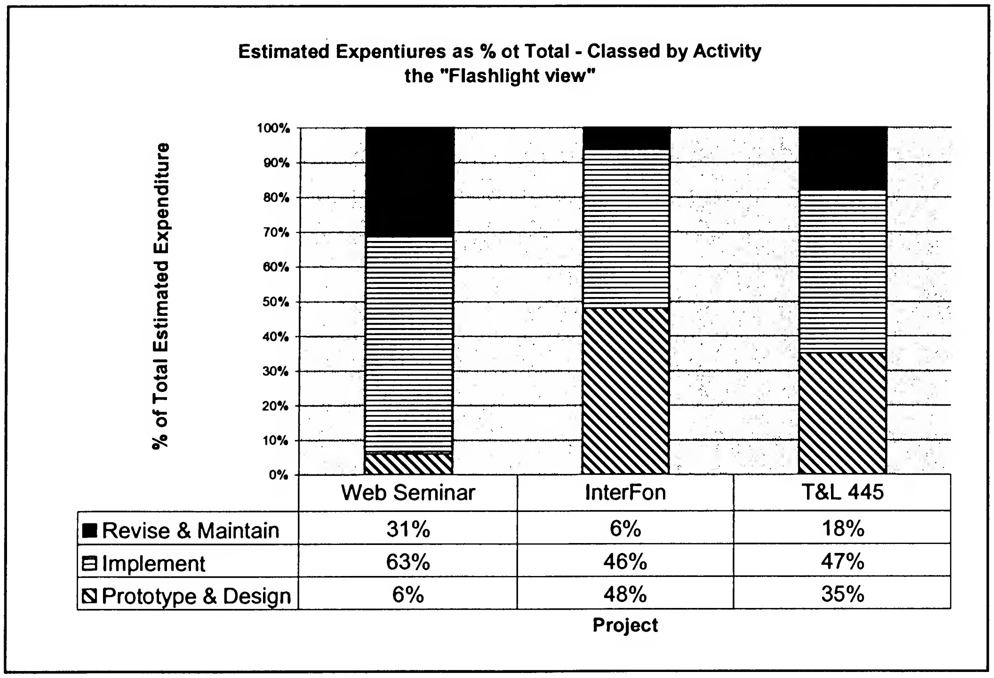
Conclusions

The salient finding of this study is: even though the web-based conferencing template costs substantially more to produce than the module approach, its cost per student week is comparable to the course conversion approach used for Teaching and Learning 445 and much less expensive when compared to the InterFon module.

This finding is not surprising, though the magnitude of the difference perhaps is. Modules designed for just a few weeks of use in specific classes will not be used by as many students as software that can be used for the whole term and in many courses. Further, as modules get increasingly sophisticated, such as InterFon, they become increasingly expensive to produce.

The Flashlight Model did a good job of pinpointing another important issue, that is, as a new technology continues to be used, the proportion of total expenses used to revise and maintain it increases. WebSeminar had been used for several semesters and had (and continues) to go through several revisions. T&L445 was in its first semester of use and InterFon was just being prototyped. Figure 6-7 shows that the ratio of expenses for the "Revise and Maintain" activity which appears to be increasing proportionally with the maturity of the product.

Figure 6-7: Cost by major activity as a percentage of total estimated costs to-date through 12/97



	Web Seminar	InterFon	T&L 445
■ Revise & Maintain	31%	6%	18%
⊟ Implement	63%	46%	47%
⧅ Prototype & Design	6%	48%	35%

This final observation may have major implications for institutions developing new technologies. The cost of the new technologies will continue to rise as they are used. Revisions and maintenance costs seem inevitable and may become a major cost of the product as it matures.

The first finding reporting the general costs and even the costs per student week could have been reached by analyzing total costs using traditional "general ledger" accounts. However, the additional and imperative finding that suggests upgrades and maintenance costs need also be considered in the development cycle, though they appear to be obvious when the costs are categorized by activity using the Flashlight Economic Model, would probably not be so obvious if we had selected to use traditional cost estimates based strictly on general ledger accounts.

Additional Considerations

The modular approach to technology development (InterFon), which targeted one part of one course or a single concept, did, it turns out, have a spin-off application. The spin-off was entirely unanticipated. However, the unanticipated utility – the preservation of the phonetic components of dying Native American languages – underscores one aspect of the problematic nature of a cost/benefit analysis. First, in the case of InterFon, the ultimate valuation of the benefits of this program, or any program of this nature was dependent upon great fortune – or great foresight, which WSU, for this project at least, cannot claim.

Second, though the language preservation application of the program in this study could be counted as an intangible benefit, there may also be a rather substantial cost. Any software program requires upgrading and maintenance if it is to persevere, and that cost will persist throughout the life of the program both in real and in opportunity costs. Whoever maintains the program is not doing something else. So the program must be maintained or responsibility transferred to a reliable, perhaps commercial, organization.

There may be a variety of ways to do this, including burning the program and preserved language into a permanent storage medium such as a CD-ROM. But there are still a number of issues necessary to assure a reasonable life span of the product, and such activities generally do not fit snuggly, at this point, into educational institutions daily business.

The entire class model (Teaching and Learning 445) was developed by an instructor of educational technology who already possessed both the resources and the expertise to put a single, complete course online. One significant advantage to this approach is that the process of developing the course also keeps the professor involved and current in his profession. Likewise, maintenance and upgrades, already significant in this project, very easily qualify as professional development that may benefit students as well as the instructor. On the other hand, that the instructor in this study was an instructor of educational technology also limits the generalization of many of the benefits noted here, particularly those that count as professional time-on-task. Our RFP process with faculty who targeted full classes and who were funded were generally not so successful, many of whom have yet, almost three years later, completed their efforts. *Funding faculty to develop their own courses depends heavily on the technology skills of the instructor involved. There is no evidence in this study that suggests that the approach would be successful with faculty in disciplines other than educational technology.*

A multidisciplinary learning space (WebSeminar, now upgraded and called the "Speakeasy Studio" after its latest revisions) allows faculty from any discipline to paste materials and assignments into the "learning space" on the WWW and then to facilitate the text-based interaction around that material. However, *the broader the base of use, the less the customizability of the application remains an advantage over commercial developers, who are making and serving learning spaces that are increasingly available and that eliminate the university's responsibility for providing upgrades and maintenance.*

In the final analysis, the three kinds of development outlined in this study may have more particulars than generalities, which qualifies the categorization of module, class and web-based conferencing template in particular ways. Each approach raises different questions. Each presents particular opportunities and catwalks particular pitfalls.

Limitations, Caveats, and Further Study

The absence of benchmarks

This analysis did not conduct a "make vs. buy" analysis. What is the lifecycle of courseware or new technologies in education? Will the cost of maintaining the systems be overwhelming? How many revisions are practical to meet requirements of new hardware, new versions of operating systems, communications systems, etc? Some of these questions suggest the ongoing nature of cost analysis. Depending upon the purpose of the study, the absence of benchmarks may be worth considering. Many problems with programming or adapting a particular "courseware" system are addressed in Ehrmann (1995).

Strategic return-on-investment indexing

The analyses presented here may be improved if they had included a Return-on-Investment analysis (or index) and/or comparing the Net Present Values of the cost of each technology. Such calculations would factor in the time-value of money and should be kept in mind for studies of investments in new technologies.

Context assessment

This analysis did not address the larger aspect of benefits – *learning*. Clearly, a cost analysis will be significantly augmented when coupled with other assessments – including other Flashlight toolkits like the Current Student Inventory, the Faculty Inventory, the planned Alumni and Community surveys.

For example, the T&L 445 course has just adapted new teaching technologies. A survey of regional principals who hire graduates from the WSU program will provide an additional depth to our perceptions of benefits that were not possible with the single model of assessment presented here. We are planning on the opportunity to enrich our cost assessments by integrating these additional tools.

The perceptions of benefits

We also discovered that many faculty and staff are incensed at putting a dollar value on the benefits of education. When this analysis was presented at a faculty forum in the spring of 1998, there were faculty who found the whole majesty of ascribing benefits to the learning process – tangible or intangible –disconcerting and even upsetting. One particularly hostile faculty member disrupted the presentation. His concerns, we suspect, reflect a general perception held by faculty that the business of teaching and learning is significantly different from other businesses to merit the same measures of scrutiny.

When we presented the cost/benefit model to the University's chief budget offer, he confirmed, from his experience, similar attitudes. Faculty will damn you if you do a cost/benefit analysis, and the public and funding constituencies will damn you if you do not.

Certainly, it is necessary to be sensitive to faculty concerns. And certainly any attempt to quantify benefits is, ultimately, reductive. On the other hand, the process of such an analysis helped us revisit our values and contextualize them into the world and into the language of legislatures and taxpayers. It is becoming increasingly clear to those of us in higher education that we need to continually communicate with our constituencies, and developing a common language is an essential aspect of any communication.

Several studies have analyzed the benefits of a college education as a whole, both to individuals and to society. Examples of personal benefits include improved individual knowledge, productivity and job market search efficiency; examples of benefits to society measure effects such as intra-family productivity, family health, social cohesion, and other benefits (Haveman and Wolfe, 1984). Another study used "data envelopment analysis" to attempt to measure the added value of top MBA programs in the U.S. (Haksever & Muragishi, 1998). Other studies have measured the economic impact of a particular university on a state's economy (Clark, Feng & Stromsdorfer, 1998). These studies may use different approaches, but they all measure the impact of a degree or program or of a total university, not a single course.

However, analyzing and trying to quantify the benefits of technology derived from individual courses is difficult and subjective.

Finally, if we fail to provide our analysis of the costs and benefits of our educational efforts, we forfeit the challenge to those who will, which, like assessment in general, often turns out to have more unpleasant consequences than the wrath of our colleagues.

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CASE STUDY 7:

THE UNIVERSITY OF HONG KONG
CHASING THE GREAT WHITE WHALE OF OPEN ACCESS COSTS

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Abstract: *In 1998, the University of Hong Kong instituted a campus-wide notebook computer programme. Among other benefits, the programme furnishes an alternative method of providing students with access to a computer and the network. At the moment, HKU continues to offer computer and network access to students in computer laboratories as well as supporting the notebook computer programme. But, in light of increasing demand and decreasing resources, decisions must eventually be taken about how best, and most cost-effectively, to provide open access. Using the Flashlight methodology, in 2000, the IT & Teaching Group undertook a cost-analysis study to answer three questions concerning the provision of open access: (1) How much did each of the two methods of providing open access for students cost? (2) Who paid for which costs, e.g., central budget, faculty or departmental budgets, students, other funding sources, or vendors? (3) Which method of providing access – laboratories or the notebook computer programme – was most cost-effective from the University's perspective?*

LOOMINGS

> *What the White Whale was to Ahab, has been hinted; what, at times, he was to me, as yet remains unsaid.*
> *Herman Melville*
> *Moby-Dick, or The Whale*[i]

Call us naïve. Like Ahab in Melville's classic 18th century novel *Moby Dick*, who went in search of a leviathan, "a Sperm Whale of uncommon magnitude and malignity, which whale, after doing great mischief to his assailants, had completely escaped them." (pp. 194-195), we boldly and fearlessly lowered away in search of the Great White Whale of information technology (IT) costs at the University of Hong Kong (HKU). Although "chancing only to hear of [them] distantly and vaguely," we specifically went in search of the costs of providing students with access to a computer and the network.

ALL ASTIR

> *A day or two passed, and there was great activity aboard the Pequod. Not only were the old sails being mended, but new sails were coming on board, and bolts of canvas, and coils of rigging; in short, everything betokened that the ship's preparations were hurrying to a close. (p. 104)*

Our work commenced in 1998 when the University of Hong Kong (HKU), after a long period of planning, entered into a three-year "Partnership" with IBM China/Hong Kong Limited, one component of which was a notebook computer programme. Under the terms of the Partnership agreement, IBM agreed to supply all incoming freshmen with a ThinkPad notebook computer at a significant discount. The University agreed to provide a subsidy, making the final cost to each student for the complete notebook bundle approximately 20-25% of the equivalent retail value. To ensure network access, the HKU Computer Centre created "ACEnet", a "plug-and-play" network that provides more than 10,000 access points across campus in the Library, dormitory rooms, classrooms, laboratories, hallways, and other places.

Altogether, after three years of the Partnership, 6,799 undergraduate students (about 82%) have ThinkPad notebook computers and are able to access a computer and networked resources from any place on- or off-campus at any time. The University, students, and IBM have invested significant resources in the programme.

When being planned by an ad hoc committee of academics and administrators, there were three major reasons put forward as to why the University should initiate a notebook computer programme:

1. Anywhere, anytime access to a computer would enhance the quality of education available to HKU students.
2. Ownership of a personal computer would improve students' information technology skills and knowledge.
3. The University would realize cost savings from instituting such a programme.

In 1999, as part of our responsibility to provide University decision-makers with information concerning information technology (IT) use on campus, we (the IT & Teaching Group within the Centre for the Advancement of University Teaching [CAUT]) decided to look closely at the third reason, and study the question of costs. [ii] Crowding on all sail, we pressed ahead with the fair, fresh wind of enthusiasm to urge us along. As envisaged, our study would compare costs between two methods currently used on campus – the notebook computer programme and open access computer laboratories – and would be completed within a month or two.

> THE ADVOCATE
> *"I was thinking of shipping."*
> *"Thou wast, wast thou? I see thou art no Nantucketer – ever been in a stove boat?"*
> *"No, Sir, I never have."*
> *"Dost know nothing about whaling, I dare say – eh?"*
> *"Nothing, Sir; but I have no doubt I shall soon learn." (p. 79)*

Thus we began our study. We were new to conducting a cost-analysis study, although we are all experienced educational researchers. If we had been asked at that time what we knew about conducting a cost-analysis study, we might have replied, like Ishmael when signing aboard the Pequod, "nothing," but we had no doubt we could learn.

In retrospect, perhaps our decision to conduct the study was naively made, without sufficient understanding of the difficulty of the task. But we set off on our voyage anyway, with the one only and all-engrossing object of hunting the White Whale of the costs related to providing students with access to computers and the network from on- and off-campus.

Like Ahab, the path to our fixed purpose was laid with iron rails. Over unsounded gorges, through the rifled hearts of mountains, under torrents' beds, unerringly we did rush. A study that we thought would take a few months turned into almost a year's work. The data that we needed and thought would be simply available to us from one or two central support unit databases turned out to be buried deep in hundreds of filing cabinets across all three of HKU's campuses.

> THE SHIP
> *She [is] a ship of the old school ... with an old-fashioned, claw-footed look about her. Long seasoned and weather-stained ... her ancient decks were worn and wrinkled. ... But to all of these her old antiquities, were added new and marvelous features ... (p. 77).*

To understand this study, and the environment in which it was conducted, it is necessary to know something about the University of Hong Kong (HKU). Sir Frederick Lugard, Governor of the British Colony, laid the foundation stone for the oldest tertiary institution in Hong Kong, on March 16, 1910. Two years later the University officially opened with two founding faculties, the Faculty of Engineering and the Faculty of Medicine. In December 1916, the first class of 28 students graduated.

Since then, HKU has grown from two faculties to ten, with the addition of faculties of Architecture, Art, Business and Economics, Dentistry, Education, Law, Social Sciences, and Science. Today there are 14,000 students (about 9,000 undergraduate, 5,000 graduate and 650 international) and more than 1,000 full-time teaching staff.

Since its humble beginnings, HKU has become one of the pre-eminent international universities in Asia. In 2000, *AsiaWeek Magazine* ranked HKU third overall among all multi-disciplinary universities in Asia. The two institutions outranking HKU, Kyoto University and Tohoku University, teach primarily in Japanese. In research, the University ranks consistently among the top few research universities in Asia and compares well to the best North American institutions.

Since 1997, the University has begun a major restructuring of its curriculum to incorporate

problem-based learning, cross-curricula activity, cross-cultural sensitivity, and to ensure that all of its students achieve information technology (IT) literacy. These efforts have paid major dividends in improved student learning, the renewal of an atmosphere of excitement and innovation, and increasing stature as a leader among universities worldwide. Thus, HKU may be accurately described as traditional, conservative, very successful, and evolving to meet new challenges.

> MOBY DICK
> *For as the secrets of the currents in the seas have never yet been divulged, even to the most erudite research; so the hidden ways of the Sperm Whale when beneath the surface remain, in great part, unaccountable to his pursuers; and from time to time have originated the most curious and contradictory speculations regarding them ... (pp. 197-198).*

IT has become an increasing and on-going expense in every educational institution's budget. Some estimates of the amount spent from University operating budgets on IT range from one percent to 25 percent, with an average of about five percent (NASULGC, 1999, pp. 10-11). But, if one looks closely enough, these costs are rarely well understood or documented.

At HKU, as elsewhere, there has been growing pressure to provide students with more and more access to computers and the network due to the increasing use of such resources in educational programmes. As the need to provide student access has increased, HKU administrators have been faced with growing, and in some cases unforeseen, costs. When we began our study, those costs seemed hidden, unaccounted, curious, and contradictory.

Our Moby Dick, the fundamental resource issue we addressed, was how best – and cost-effectively – the University could provide students with access to computer and networked resources. Prior to 1998, student access to computers and the campus network (and hence the Internet) for general-purpose use at HKU was provided only by means of "open access" computer laboratories, some centrally maintained by the Computer Center; others set-up by individual faculties, departments, or other academic units. The workstations in open access labs are pre-loaded with a variety of general productivity or network software including word processors, spreadsheets, web browsers, email applications, and so forth.

What distinguishes open access labs from other computer labs on campus is that they are not typically used for instruction, i.e., to host a computing class with an instructor, and they are not equipped or designed for discipline-specific use, e.g., a GIS computer lab for Geography or a CAD/CAM lab for Architecture students.[iii]

Since 1998 the HKU/IBM Partnership has provided incoming students with an alternative means to access a computer and the network. Students may purchase a notebook computer and plug into ACEnet, a "plug and play" network created on campus for ubiquitous network access. In addition, the capacity of the Computer Centre's modem pool that provides off-campus access to students and staff was greatly enhanced.

At the moment, HKU continues to offer computer and network access to students in computer laboratories as well as supporting the notebook computer programme. But, in light of increasing demand and decreasing resources, decisions must eventually be taken about continuing the notebook programme, maintaining open access laboratories, or developing some approach inclusive of both the notebook computers and laboratories. And, in either case – open access labs and the notebook computer programme – the question of who bears which specific costs - the University, faculties and departments, and individual students - is an important factor that HKU administrators need to consider in making resource decisions.

Cost Analysis Model

The cost analysis model we used for the study was based on the seven-step "activity-based costing (ABC)" model in the *Flashlight Cost Analysis Handbook, Version 1.0* (Ehrmann & Milam, 1999) published by The Teaching, Learning, and Technology Group (TLT Group):

- Identify specific questions.
- Identify the outputs.
- Identify the activities that go into producing the outputs.
- Identify the academic and support units that produce the outputs.
- Identify the resources these units use to produce the outputs.
- Calculate costs for these activities.
- Tally the costs of all activities to arrive at overall costs.

The *Handbook* provided us with scaffolding upon which we could construct our study for which we were very grateful. We read it carefully, scrutinized the case studies in the appendices, and embarked on our voyage.

Specific Questions

Our cost analysis was intended to answer three questions:

1. How much did each of the two methods of providing open access for students cost?[iv]
2. Who paid for which costs, e.g., central budget, faculty or departmental budgets, students, other funding sources, or vendors?
3. Which method of providing access – laboratories or the notebook computer programme – was most cost-effective from the University's perspective?

Output

Determining the fundamental output of interest was more difficult than first realized, and – in the end – it was one of the more controversial decisions made. As the *Flashlight Manual* affably notes, "there are many ways to express outputs" (Ehrmann & Milam, 1999, p. 7).

In our case, the fundamental resource issue we were addressing was how best the University could invest its limited resources to provide students with access to computers and the network. But which students should we include and what specific metric or indicator, or "output", should we use? Should we attempt to include open access costs for all students, undergraduate and postgraduate, or limit the study to undergraduate students only? In the end, we had to limit the study to undergraduate students and ignore costs that might have been attributed to graduate students for two major reasons.

First, the notebook computer programme was primarily intended to serve the undergraduate student population. Although postgraduate students and staff are offered the opportunity to purchase a notebook computer, they do so without a University subsidy and at a less favorable discount from the vendor. Therefore, we knew that few postgraduate students had participated in the notebook programme and we had no way of knowing whether or not they already owned a notebook computer purchased from a different source. We could not determine what costs, if any, were associated with graduate student use of notebook computers and therefore, for the purposes of the study, we assumed there were none.

Second, we had no reliable way of ascertaining how postgraduate students across campus in the various disciplines were being provided with access to a computer and the network in other ways. We did know from anecdotal evidence that the provision of access varies considerably from academic unit to academic unit and from discipline to discipline. In some departments, individual postgraduate students are provided with a workstation and network access from grant monies. In other departments, two or more postgraduate students in an office suite are provided with access to a single computer. Some departments do not provide any computer or network access to postgraduate students, in which case they may purchase and use their own notebooks or workstations on campus, or simply do without. And, of course, postgraduate students do have access to workstations situated in the campuses' open access laboratories.

The latter factor was ignored. That is, when determining open access laboratory costs per student, we did so without consideration of postgraduate student use. We had no way of tracking how many postgraduate students make use of computers in open access laboratories nor how often they use them. We also had no evidence that if postgraduate student use of computers in laboratories were to be disallowed, that the number of such laboratories, or their associated costs, would decrease. In fact, the opposite may be true as more departments are now opening such labs. But excluding the costs associated with providing laboratory access to postgraduates, who make up 35% of the total student population, has been a point of controversy.

The second point of controversy about our choice of "output" has been our decision to use costs per "hour of accessibility" as a metric. We <u>did</u> <u>not</u> consider students' <u>actual</u> hourly use of either open access laboratory workstations or notebook computers, but rather compared the hours individual computers were <u>available</u> for use. In the case of open access laboratories, this meant calculating the number of computers times the number of hours each laboratory was open to students. In the case of notebook computers, since students own them and could in theory have them with them at all times, this meant calculating the number of students times the number of days in the academic year times 24 hours a day. This has been seen as an unfair comparison, since students do not usually use their notebook computers 24 hours a day.

We decided to focus on <u>access</u> rather than <u>use</u> because we could measure one but not the other. We could measure the hours of access available in

computer laboratories but could not obtain reliable data about student use of individual computers in these labs. Such data do not exist and are not collected.[v] And we also reasoned that anywhere, anytime access had additional value in the educational process to notebook using students that could not be included in the study quantitatively, but which could help justify our approach.

Second, we focused on access rather than use because the University can determine whether or not to provide lab access and at what level, but it cannot dictate nor too accurately project student demand. Demand varies greatly from discipline to discipline, week to week, day to day, and student to student.[vi] Engineering students probably need more access than students in the Arts. And, any attempt to measure student use of workstations in open access laboratories would be unable to factor in whether more use would have been possible, indeed desirable from the students' point of view, had more workstations been available at any given time.

In conclusion, we picked the cost of providing access to a computer and the network per hour as the "output" for the study. However, we also considered costs[vii] from a variety of other perspectives as you will see.

> THE FIRST LOWERING
> *"There she blows! There! There! There! She blows! She blows!"*
> *"Where away? "*
> *Instantly all was commotion.*
> *"Lower away then; d'ye hear?" shouting across the deck. "Lower away there, I say." ... the sheaves whirled round in the blocks; with a wallow, the three boats dropped into the sea ..." (pp.234; 236-237)*

We believed our data collection efforts would be limited to a simple phone call or two. How little we understood the situation! The data necessary to complete the study for identifying the actual cost of PC laboratories were not readily available from a central source, for reasons of complexities of funding sources and differences in time and price for the PCs and other fitting-out works.

The Finance Office (FO) handles nearly 100,000 purchase orders every year for items paid for from many sources of funding including a central IT budget for the Computer Centre (CC), individual one-line budgets for academic units, donations, grants, and so forth. And large individual purchase orders are often used to buy multiple items, some relevant to our study and some not.

In order to provide us with the necessary information concerning IT purchases and expenses at the academic unit level, someone in the FO would need to examine thousands of purchase orders, scrutinizing each and individually itemizing those costs of interest to us. Doing so would simply be too time consuming and costly. Plus, whatever data they did have concerning IT expenditures by faculties, departments, and other academic units would not be adjusted to reflect the depreciation of equipment purchased in previous years.

The issue is further complicated at HKU by two other factors. First, because academic unit funding is by one-line budget, there are fewer restrictions on how the money may be spent, i.e., one department may choose to spend a higher percentage of the total budget on IT-related costs while another spends less. Second, although the University does negotiate pricing with major IT vendors centrally through the CC, individual departments may choose to purchase IT directly from vendors, negotiating pricing and maintenance contracts individually for specialty items of equipment or software. This system provides a higher degree of autonomy to academic units, but it also became necessary to collect data from each unit.

> LESS ERRONEOUS PICTURES OF WHALES
> *And all the while the thick-lipped leviathan is rushing through the deep, leaving tons of tumultuous white curds in his wake, and causing the slight boat to rock in the swells like a skiff caught nigh the paddle-wheels of an ocean steamer. Thus, the foreground is all raging commotion; but behind, in admirable artistic contrast, is the glassy level of a sea becalmed ... (p. 291)*

In February 2000, we began meeting with representatives from the FO and the Computer Centre (CC) to solicit assistance and advice. Staff from these organizations provided invaluable assistance throughout the study. The FO explained the accounting procedures for IT purchased centrally, identified how costs were calculated and depreciated, provided extensive data concerning campus-wide costs (i.e., paid for from the central budget), and volunteered to serve as liaison with the campus Estates Office which is responsible for building, renovating, and maintaining the HKU physical plant, and hence bore some of the expenses for both open

access programmes. They also strongly advised us to use a "standard cost" approach for the cost comparisons, rather than the ABC approach. The CC staff provided descriptions of all centrally managed open-access laboratories as well as the costs related to equipping, maintaining, and operating them. Furthermore, they provided data about the costs of creating ACEnet.

Having established precisely what information would be available centrally concerning open access laboratories and the notebook computer programme, we met informally with a few friendly heads of Departments to explain what we were trying to accomplish, and solicit their feedback about what kinds of information about IT expenses could be gathered directly from academic units.

These discussions led to two important decisions. First, we would need to limit the amount of information requested because in most cases overworked Departmental secretaries would be responsible for collecting the data for us and would be much less likely to cooperate with the study if doing so were to be too time consuming. And second, we would have to accept estimates for some costs because departmental records were often incomplete or, as in the case of the FO, costs which we were interested in were buried in bulk purchase orders and for all intents and purposes unidentifiable.

> LEG AND ARM
> *"Hast seen the White Whale?" (p. 476)*

We decided to use two methods to solicit information from individual academic units, email requests for information and a self-administered Excel spreadsheet also dispatched by email. Because we were, in a sense, comparing apples and oranges when comparing the costs related to open access laboratories and the notebook computer programme, we treated each as a separate study. For each we followed the Flashlight ABC approach identifying specific sub-questions, outputs, activities that produced the outputs, academic and support units that helped produce the outputs, resources used by these units, then calculated the costs for the activities, then finally tallying all of the costs for both approaches. In the end, we compared the costs per hour of access between the two methods.

> THE CHASE — FIRST DAY
> *"There she blows! — There she blows! A hump like a snow-hill! It is Moby Dick!" (p. 595)*

Study of Open Access Laboratories

In the case of open access laboratories, the sub-questions were:

- How much does it cost to provide one hour of access to a computer and the network for undergraduate students through open access computer labs/workstations?
- Who pays for what in providing the computer and network access in open access laboratories, i.e., what costs are funded from the University's central budget, faculty or departmental budgets, and other funding sources respectively?

The output was one hour of access to a networked computer in an open access lab. The activities required to produce this output included the setting up, operation, and maintenance of the computer labs and workstations. As for the organizational units, at HKU there could be as many as 68 units directly or indirectly involved in providing access by means of open access laboratories including the Computer Centre, Estates Office and Library at the campus-wide level, nine faculties and one school at the faculty level[viii], and 55 academic departments/units (including the English Centre and Language Centre) at the departmental level.

Regarding the inputs or resources consumed in carrying out the activities, with the help of the Finance Office and the Computer Centre costs were identified in two general categories: setup costs and recurrent cost.

The specific input or cost items under each category were as follows:

Setup Costs	***Recurrent Costs***
• Hardware & software • Network connections • Fan coil unit system for air-conditioning • Lighting • Other electric appliances • Builders (for renovations) • Furniture	• Hardware maintenance agreements • Hardware & software upgrades • Staff support - maintenance, problem fixing, general administration • Space (rental rate) • General maintenance - lamp replacement, fan coil unit maintenance, minor repairs to furniture, minor repairs to door locks, ironmongery, false ceiling tiles, general cleaning • Management charge - apportioned operation & maintenance costs of lifts and main chiller water plant of the building • Utilities - lighting, power for PCs and air-conditioning

For the 65 academic units, a self-administered Excel spreadsheet was sent to the unit heads via email to collect relevant data. Heads were requested to fill in the spreadsheet with the following information[ix] and return it electronically:

- The number of workstations in individual labs
- The total weekly access hours of individual labs
- The estimated total setup cost
- The estimated total annual recurrent cost
- The estimated proportion (in percentage) of these costs being funded from the central budget, the departmental budget, and other funding sources respectively
- A contact person and telephone number (for follow-up purposes)

Data collection started in April 2000 and ended in mid-June 2000 after one chaser email and one telephone follow-up call were administered. Of the 67 units directly involved in providing open access network access, only 14 did not reply or provided incomplete replies on the Excel spreadsheet survey (4 faculties and 10 departments). The other 53 replies included six faculties, 43 departments, the Library, the Computer Centre, the English Centre, and the Language Centre. The response rate was 79%.[x] The Finance Office provided detailed information concerning costs supported by the central budget including space, renovations, furniture, utilities, general maintenance, management, and so forth.

There were a total of 873 workstations in open access labs in 13 units or departments on campus, providing a total of 108,337 computer and network access hours per week. Of the 43 departments that sent replies, 30 had no computer labs. The total and average expenses in setting up the labs and an average setup cost per workstation were calculated. And finally, an average cost per hour of access was calculated. With the exception of 10% of the total setup cost and one percent of the total recurrent cost, costs were borne by the University, either from the central budget or faculty and department budgets.

Setup and recurrent costs for the notebook programme included the following:

Setup Costs	*Recurrent Costs*
• Staffing • Facilities (including renovation, furniture and space) • Network upgrading • Administration/publicity • Security • Maintenance Repair • Insurance • Hardware • Software	• Staffing • Facilities (including renovation, furniture and space) • Network upgrading • Administration/publicity • Security • Maintenance Repair • Insurance • Hardware • Software

THE CHASE — SECOND DAY
"There she blows! —she blows! —she blows —right ahead!" was the masthead cry. "Aye, aye!" cried Stubb, "I knew it – ye can't escape – blow on and split your pout, O whale! (p. 605)

Study of Notebook Computer Programme

In the case of the notebook computer programme, the sub-questions were:

- How much does it cost to provide one hour of access to a computer and the network for undergraduate students through the notebook computer programme?
- Who pays for what in providing access to a computer and the network via the notebook computer programme, i.e., how much of the costs are funded from the University's central budget, faculty and departmental budgets, students and parents, the vendor, and other sources?

The output was one hour of access to a computer by means of notebook computer ownership and access to the network by means of ACEnet and the University's modem pool. The activities required to produce this output include the setting up and operation of the notebook computer programme, e.g., publicity, printing of flyers and handouts, the installation of pre-loaded software, distribution of the computers, and so forth. It also includes the installation of additional network access points for ACEnet, some facilities renovation (e.g., shelves in hallways for notebook computers near ACEnet access points in the Run Run Shaw Building, the space for the vendor's service centre), and maintenance of the notebook computers.

The following academic and support units were involved in the implementation and maintenance of the notebook computer programme:[xi] Centre for the Advancement of University Teaching, Computer Centre, Estates Office, Faculty of Education, Finance Office, Library, Registry, and the Vendor (IBM).

Heads of all involved academic and support units were initially contacted by email to request information concerning costs associated with the notebook computer programme. In addition, meetings were held with representatives from the Finance Office, Computer Centre, and the University Library. The vendor was contacted by email and telephone. All of the organizations contacted provided information for the study in a variety of ways including email, telephone interview, fax documents, and verbally and in documents collected during meetings.

A total of 6,799 notebook computers were sold to incoming students during the three years of the notebook computer programme.[xii] These computers provide 1,142,232 total access hours per week; this is 24 hours a day, 7 days a week access for participants from on- or off-campus.

The total annual recurrent cost for the 6,799 notebook computers and an average cost per notebook computer were calculated. The University paid about 55% of the setup cost and about 88% of the recurrent cost. Students paid about 45% of the setup cost and no recurrent cost. The vendor paid less than one percent of the setup cost and about 12% of the annual recurrent cost.

THE CHASE—THIRD DAY
"Heart of wrought steel!" murmured Starbuck gazing over the side, and following with his eyes the receding boat–—"canst thou yet ring boldly to that sight? —lowering thy keel among ravening sharks, and followed by them, open-mouthed to the chase; and this the critical third day? —For when three days flow together in one continuous intense pursuit; be sure the first is the morning, the second the noon, and the third the evening and the end of the thing—be that end what it may." (p.617)

Comparing the Two Approaches

We undertook the cost analysis study to answer three questions: how much do both approaches to providing students with access to a computer and the network cost, under either approach; who pays which costs; and finally, from the University's perspective, which approach is most cost-effective?

Any attempt to answer these questions must be tempered by the fact that not all of the costs associated with either programme are included, that some of the costs may be inaccurate due to estimations, and that some misunderstandings of what data were required may have resulted in inaccurately reported figures. Nonetheless, the authors are confident that the costs reported are reasonable approximations of the true costs and that missing data would not significantly change the results.

How Much Does Each Approach Cost?[xiii]

Throughout the rest of this paper, costs are reported in artificially created "Resource Units", rounded to the nearest tenth of a unit, instead of in actual Hong Kong Dollars. This ensures confidentiality of financial data while still allowing readers to make comparisons between the two approaches. As regards the first question, "How much does each of the two methods of providing open access to undergraduate students cost?" Table 7-1 summarizes the total and the University's costs associated with each approach it then extrapolates the costs for a notebook computer programme in which it assumes that 100% of undergraduate students participate.

The total setup costs for both approaches amounts to only about 4% of the annual University budget.[xiv] The annual recurrent costs for both programmes combined are about 0.8% of HKU's annual budget.[xv] If one amortizes setup costs for three years, the length of the current HKU/IBM Partnership Agreement, and adds the recurrent costs, then the University uses about 2% of its annual budget each year to provide students with computer and network access under both approaches combined.

Who Pays For Which Costs?

Under the open access laboratory approach, the University, i.e., the central budget, faculty or departmental budgets, pays 90% of the setup cost and 99% of the recurrent cost. The remaining cost is funded from other means including grants, donations and so forth.

Under the notebook computer approach, the University's share of the setup cost is about 55% and approximately 88% of the annual recurrent cost. Students pay about 45% of the setup cost and no recurrent cost. The vendor pays less than one percent of the setup cost and pays about 12% of the annual recurrent cost (see Table 7-2).

Table 7-1: Programme Expenditures in Resource Units

Approach	Total Cost		Total University Cost	
	Setup	Recurrent	Setup	Recurrent
Labs	24.9	18.8	22.3	14.6
Notebooks (82%)	135.4	5.2	73.7	4.6
Notebooks (100%)	157.9	5.1	84.0	4.6

Table 7-2: Who Pays What Percentage of Total Cost?

	Open Access Laboratories		Notebook Programme	
	Setup %	Recurrent %	Setup %	Recurrent %
University	90	99	55	88
Students	0	0	45	0
Vendor	0	0	0	12
Other	10	1	0	0
Total:	100	100	100	100

From the University's Perspective, Which Approach is Most Cost-Effective?[xvi]

For this question, no simple answer is possible. Which approach is most cost-effective depends on how one views the data and what value is assigned to various issues. We attempt to draw no final conclusion, but rather suggest several ways of looking at the results of the study from which others may draw conclusions.

Total Amount Spent

First, if we consider only the total amount of money spent on each approach, then the open access laboratories would be more cost-effective because providing access in laboratories is less expensive. The notebook programme approach, if extrapolated to include providing 100% of undergraduate students with computers and network access rather than just the 82% who have chosen to participate in the voluntary programme, would be 1.5 times more expensive than the existing open access laboratories which, in theory, provide 100% of undergraduates with such equipment and access (albeit more inconveniently and for fewer hours). From this perspective, one can conclude that the open access laboratories approach is more cost effective than the notebook computer programme (see Table 7-3).

Computers Purchased

Another way to answer the question would be to ask what the money spent actually bought. Taking into account only the University's expenses, the cost per machine for setup for open access labs is about 2.5 times more expensive than the notebook programme with 100% participation. The annual recurrent costs for the open access laboratories are about 31 times more expensive than the notebook programme with 100% participation.

In the case of the open access laboratories, the resource units expended purchased student access to 873 computer workstations on campus for three years, a 9.5:1 ratio of students to computer. In contrast, suppose all the students in the University were to acquire notebooks for three years (a total of 8,294 notebooks -- about 10 times the number of computers currently available in laboratories); this would cost only 1.5 times as much as the current expenditure on labs, but would provide all students with 24 x 7 access. From this perspective, one can conclude that the notebook computer programme is more cost effective than the open access laboratories approach (see Table 7-4).

Table 7-3: Programme Expenditure in Resource Units

Approach	University Cost (only)		
	Setup	Recurrent	Setup + Recurrent × 3
Labs	22.3	14.6	66.2
Notebooks (82%)	73.7	4.6	87.3
Notebooks (100%)	84.0	4.6	97.7

Table 7-4: Number of Computers & Student/Computer Ratio Under Each Approach

Approach	No. of Computers	Student/Computer Ratio
Open Access Laboratories	873	9.5:1
Notebook Computer Programme (100%)	8,294	1:1

<u>**University Costs Per Access Hour**</u>

A third way of assessing cost-effectiveness would be to compare the two approaches in terms of the cost of providing one hour of student access to a computer and the network. Over three years, providing student access to a computer and the network in open access laboratories costs the University almost nine times (8.7) more per hour of access than under the notebook computer approach at 100% participation. From this perspective, one can conclude that the notebook computer programme is more cost effective than the open access laboratories approach.

Other Considerations

Apart from the question of the resources expended on either approach, and how best to view those expenditures, there are less quantitative issues that may be factored into any decision concerning which approach is most cost effective. These include that student costs are a significant proportion of the notebook programme, whereas they are non-existent under the laboratory approach; that alternative uses of the resources spent on either approach – should one be terminated – could provide other enhanced educational opportunities; that there may be added educational value in providing students with 24 hours a day, 7 days a week, computer and network access; and that costs associated with space on campus might be saved if the University adopted only one or the other approach.

> EPILOGUE
> *"The drama's done. Why then here does any one step forth? — Because one did survive the wreck." (p. 624)*

We began our study mindful of the advice contained in the Higher Education Funding Council for England's report, *Information Systems and Technology Management: Value for Money Study*, which notes, "most institutions surveyed do not aggregate their total institutional expenditure on IS/IT. Without such information, it is very difficult for institutions to assess the value (financial or otherwise) obtained from their investment in information technology, or to manage that investment in a fully effective way" (HEFCE, 1998, p. 14).

We believe that we answered two of the three questions posed at the beginning of the study. We are reasonably certain that we have been able to report close approximations of how much is being spent on each open access approach and who is paying for what. As to the last question, which approach is most cost-effective from the Universities perspective, we think that we have provided useful information, which could help the University's policy-makers make that judgment.

We also believe that this study will help HKU administrators assess the value of investments made in providing open access to our students. Our efforts to harpoon these costs began in February 2000 and did not fully draw to a close until our final report was presented in December 2000. But ultimately, it may be that our efforts – like Ahab – will sink beneath the waves without a trace as the University struggles with more pressing and important issues that it faces. In the end, perhaps the only result will be that, *"the great shroud of the sea rolled on as it rolled five thousand years ago"* (p. 624).

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[i] All quotations from *Moby-Dick or The Whale*, Herman Melville, taken from the 1992 edition published by Penguin Books USA Inc., New York.

[ii] The issue of whether notebook ownership has improved students' IT skills or the quality of their education is being dealt with in other studies. See http://www.hku.hk/caut/Homepage/itt/5_Reports/5_3surveys.htm for details.

[iii] This distinction does not always hold. Some teaching laboratories and specialty labs are open to students at specific times for general purpose use. For the purposes of this study, academic units were asked to exclude laboratories used <u>only</u> for such "specialty" computing purposes, but to include laboratories that were used for such purposes but were also used to provide "open access". For the latter, academic units were asked to provide the number of hours these labs were open for general use.

[iv] The study considers this question over a period of three years, 1998-2001, the duration of the first Partnership agreement covering the notebook computer programme.

[v] It could be argued that one could compare the actual student use of notebook computers, which our data from other surveys indicates averages around 10 hours per week, with the result of a calculation in which one determines the number of hours each lab is open times the number of workstations in the labs and divide that result by the number of students not participating in the notebook computer programme. But, as our notebook computer programme participants also use the open access labs, this would give a spurious result.

[vi] Any attempt to "average" student use may be useful in some ways, e.g., to project how many open access labs will meet most student needs most of the time, but may also be misleading. For example, calculations of the number of workstations necessary to meet students' needs for access based on such averages may lead to long queues for such access prior to paper deadlines and examinations week.

[vii] Throughout this paper we discuss "costs". But some costs are paid at one time at the beginning of a programme and others are recurrent, i.e., must be paid periodically over the life of a programme. The "total setup cost" described here can be considered as the *total initial capital investment* for each of the two approaches. The "total annual recurrent cost" can be interpreted as the *total operational costs* of the two approaches *each year*. In other words, in the case of the open access labs, the total setup costs discussed are the capital investment for setting up open access workstations on-campus in laboratories, and the total annual recurrent cost figures are the total costs for operating these laboratories each year. Likewise, in the case of the notebook programme, the total setup costs are the capital investment for providing undergraduate students with notebook computers and network access, and the total annual recurrent cost figures are the costs for maintaining the programme and operating the network infrastructure each year.

[viii] Since the survey, the School of Economics (from within the Faculty of Social Sciences) and the School of Business have been merged to form a new Faculty.

[ix] Admitting the complexity and the budgetary sensitivity of the analysis, instead of requesting the unit heads to provide a detailed breakdown of the information of the specific cost items stated in the last section, they were requested to only give a "lump-sum" of the setup and recurrent costs.

[x] The Estates Office was not included in the calculation of the response rate.

[xi] Concurrent with the implementation of the notebook computer programme, the English Centre and the Department of Ecology and Biodiversity's Virtual School of Biodiversity received special funding for the development of on-line curricula. This funding was not taken as a part of the expenses related to the notebook computer programme because the curricula are available on-line to anyone from either a workstation in a laboratory or a notebook computer plugged into ACEnet.

[xii] As noted earlier, the notebook computer programme is voluntary and not all students chose to participate. During the three years of the programme, 82% of eligible students chose to participate. This does not mean that only 82% of eligible students have a notebook computer. In the survey of non-participants mentioned earlier in this report, 98% said that they owned a computer prior to coming to HKU. Of these individuals, one percent said that they owned a notebook computer. However, these computers were not included in the study.

[xiii] Throughout the rest of this paper, costs are reported in artificially created "Resource Units", rounded to the nearest tenth of a unit, instead of in actual Hong Kong Dollars. This ensures confidentiality of financial data while still allowing readers to make comparisons between the two approaches.

[xiv] Setup costs within the report are calculated as one-time costs because amortization of the various items included takes place on different schedules, making annual costs difficult to isolate. In reality, these costs are distributed over a number of years, amounting to much less than 3% of the University's annual budget.

[xv] Conversely to setup costs, if hardware, network cabling, and so forth are in fact amortized over a period of time, these costs would rise but would still be a small percentage of the University's annual budget.

[xvi] It is wise to remember that we discuss cost-effectiveness only from the University perspective. Under the open laboratory approach, student costs are essentially zero and vendor costs are much lower. From the perspective of students or vendors, the answer to this question could be very different.